JOURNAL

OF

ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOLUME 3, 1910

JOURNAL OF ECONOMIC ENTOMOLOGY PUBLISHING CO.
CONCORD, N. H.
1910.

Contents

[1] Withdrawn for publication elsewhere.

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American Association of Economic Entomologists

(Organized in 1889)

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LIST OF MEETINGS AND PAST OFFICERS

First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President, C. V. Riley; First Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 17–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wis., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Col., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburg, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29–30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

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Plate 1 (Frontispiece)

EXPLANATION OF PLATE I (FRONTISPIECE)

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2 Herbert Osborn
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24 G. H. Hollister
25 A. I. Bourne
26 H. P. Wood
27 C. W. Hooker
28 R. W. Braucher
29 B. H. Walden
30 H. J. Speaker
31 C. R. Crosby
32 F. H. Mosher
33 L. M. Peairs
34 A. H. Rosenfeld
35 G. W. Herrick
36 M. H. Swenk
37 H. S. Smith
38 J. N. Summers
39 Robert Parker
40 F. L. Washburn
41 C. T. Brues
42 W. C. O'Kane
43 W. M. Wheeler
44 H. L. Price
45 John Barlow
46 R. A. Vickery
47 P. F. Williams
48 F. B. Lowe
49 W. S. Abbot
50 Franklin Sherman, Jr.
51 J. L. Randall
52 R. I. Smith
53 H. E. Hodgkiss
54 O. A. Johannsen
55 A. F. Conradi
56 G. G. Ainslie
57 W. A. Thomas
58 R. L. Webster
59 W. E. Rumsey
60 L. Caesar

JOURNAL

OF

ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 3 FEBRUARY, 1910 No. 1

Proceedings of the Twenty-Second Annual Meeting of the American Association of Economic Entomologists

The twenty-second annual meeting of the American Association of Economic Entomologists was held at Harvard Medical School, Brookline, a suburb of Boston, Mass., December 28–29, 1909.

The business proceedings follow in Part I, while the addresses, papers and discussions will be found in Part II.

PART I

The meeting was called to order by President W. E. Britton at ten o'clock a. m., Tuesday, December 28th.

The attendance averaged one hundred members and visitors. The following members were present:

George G. Ainslee, Clemson College, S. C.; Arthur I. Bourne, Washington, D. C.; R. W. Braucher, Washington, D. C.; W. E. Britton, New Haven, Conn.; C. T. Brues, Forest Hills, Mass.; A. F. Burgess, Washington, D. C.; Lawson Caesar, Guelph, Canada; C. W. Collins, Melrose Highlands, Mass.; A. F. Conradi, Clemson College, S. C.; Mel. T. Cook, Newark, Del.; R. A. Cooley, Bozeman, Mont.; E. C. Cotton, Knoxville, Tenn.; C. R. Crosby, Ithaca, N. Y.; R. A. Cushman, Washington, D. C.; J. J. Davis, Urbana, Ill.; E. B. Engle, Harrisburg, Pa.; E. R. Farrer, South Lincoln, Mass.; E. P. Felt, Albany, N. Y.; W. F. Fiske, Melrose Highlands, Mass.; S. A. Forbes, Urbana, Ill.; H. L. Frost, Arlington, Mass.; B. N. Gates, Washington, D. C.; H. Garman, Lexington, Ky.; C. P. Gillette, Fort Collins, Colo.; A. G. Hammar, Washington, D. C.; T. J. Headlee, Manhattan, Kan.; G. W. Herrick, Ithaca, N. Y.; C. Gordon Hewitt, Ottawa, Canada; W. E. Hinds, Auburn, Ala.; E. F. Hitchings, Augusta, Me.; H. E. Hodgkiss, Geneva, N. Y.; W. J. Holland, Pittsburg, Pa.;

G. H. Hollister, Hartford, Conn.; C. W. Hooker, Washington, D. C.; L. O. Howard, Washington, D. C.; S. J. Hunter, Lawrence, Kan.; O. A. Johannsen, Orono, Me.; F. A. Johnston, Amherst, Mass.; Nathaniel T. Kidder, Milton, Mass.; F. W. Lowe, Detroit, Mich.; A. D. McGillivray, Ithaca, N. Y.; J. H. Merrill, Danvers, Mass.; F. H. Mosher, Melrose Highlands, Mass.; A. P. Morse, Wellesley, Mass.; W. C. O'Kane, Durham, N. H.; Herbert Osborn, Columbus, Ohio; J. R. Parker, Amherst, Mass.; P. J. Parrott, Geneva, N. Y.; Edith M. Patch, Orono, Me.; L. M. Peairs, College Park, Md.; E. E. Philbrook, Portland, Me.; J. L. Phillips, Blacksburg, Va.; Asa O. Pike, Springvale, Me.; W. J. Price, Blacksburg, Va.; J. L. Randall, Pittsburg, Pa.; F. W. Rane, Boston, Mass.; W. A. Riley, Ithaca, N. Y.; E. P. Ripley, Weston, Mass.; D. M. Rogers, Boston, Mass.; A. H. Rosenfeld, Baton Rouge, La.; W. E. Rumsey, Morgantown, W. Va.; E. D. Sanderson, Durham, N. H.; A. F. Satterthwait, Harrisburg, Pa.; Wm. Saunders, Ottawa, Canada; N. E. Shaw, Columbus, Ohio; Franklin Sherman, Jr., Raleigh, N. C.; Henry Skinner, Philadelphia, Pa.; Harry S. Smith, Melrose Highlands, Mass.; J. B. Smith, New Brunswick, N. J.; R. I. Smith, West Raleigh, N. C.; A. M. G. Soule, York Village, Me.; A. L. Stene, Kingston, R. I.; H. E. Summers, Ames, Iowa; J. N. Summers, Amherst, Mass.; H. A. Surface, Harrisburg, Pa.; Myron H. Swenk, Lincoln, Neb.; T. B. Symons, College Park, Md.; W. R. Thompson, Melrose Highlands, Mass.; P. H. Timberlake, Melrose Highlands, Mass.; R. A. Vickery, Washington, D. C.; B. H. Walden, New Haven, Conn.; F. L. Washburn, St. Anthony Park, Minn.; R. L. Webster, Ames, Iowa; W. M. Wheeler, Boston, Mass.; R. D. Whitmarsh, Amherst, Mass.; E. L. Worsham, Atlanta, Ga., and L. H. Worthley, Boston, Mass.

Among the visitors present, the following were noted:

Frank A. Bates, South Braintree, Mass.; M. B. Cummings, Burlington, Vt.; G. R. Cushman, Baltimore, Md.; W. P. Headden, Fort Collins, Colo.; P. L. Huested, Blauvelt, N. Y.; F. N. Fagan, Columbus, Ohio; W. H. Gates, Baton Rouge, La.; C. F. Jackson, Durham, N. H.; W. S. Regan, Amherst, Mass.; H. J. Speaker, Port Clinton, Ohio; Dr. C. W. Stiles, Washington, D. C.; L. R. Taft, East Lansing, Mich.; P. F. Williams, Auburn, Ala., and R. Wooldridge, Melrose Highlands, Mass. A number of ladies were also present at each session.

The report of the Secretary was read as follows:

REPORT OF THE SECRETARY

At the time of the last annual meeting the roll of the Association included 252 members. The membership was then increased by the election of one active, 38 associate and two foreign members and 16 associate members were transferred to the active roll. During the year one member in each class has been called by death, namely, Prof. Mark Vernon Slingerland, B. H. Guilbeau and Dr. A. Giard. The present roll contains the names of 118 active, 124 associate and 46 foreign members, so that the year has shown an increase in each class of membership and a net gain including all classes of 36.

Nearly twenty applications for membership have already been received by the Secretary and referred to the Committee on Membership, which forecasts a substantial gain in membership before this meeting shall have closed.

The Secretary has revised and circulated the list of common names of insects adopted by the Association, as directed at the last meeting, and together with the increasing correspondence and the work required on the JOURNAL has not lacked employment for such spare time as could be devoted to the work. The records of the dues paid by members has been transferred to a card catalogue so that the information can be more readily available.

By vote of the Executive Committee the Secretary was authorized to expend for clerical assistance such amount as was deemed necessary, the total not to exceed one half of the unexpended balance of the previous year; $15.50 has been used for this purpose.

The Association is in a good financial condition, as will be seen in the following statement:

FINANCIAL STATEMENT.

Balance on hand, December 28, 1908			$91.57
By amount received for dues, 1909			164.00
To stenographic report 1908 meeting	$32.45		
stamps and stamped envelopes	38.91		
printing	38.50		
card catalogue case and cards	6.35		
clerical work, secretary's office	15.50		
supplies	1.80		
telegraph and express charges	.87		
		$134.38	
Balance in treasury		121.19	
		$255.57	$255.57

Respectfully submitted,

A. F. BURGESS, *Secretary*.

By vote of the Association, the report was accepted and referred to the Auditing Committee, for special report later in the session.

The report of the Committee on Nomenclature was presented by Mr. Herbert Osborn, and, after a general discussion and various changes which were made in the insect names recommended for common use, it was adopted in the following form:

REPORT OF THE COMMITTEE ON NOMENCLATURE

The committee recommends: First, That the use of a common name for both larval and adult forms of an insect be permissible in cases where a common name for each form is already in general use and is properly distinctive; the policy for adoption of such names by this Association to be the same as for adoption of any single name, that is, each name to be considered on its merits;

Second, That use of different names for a given insect for geographic regions be discouraged, and officially indorsed only when the circumstances clearly require such usage in order to meet the conditions existing in such region. In the majority of such cases it is believed that it will be better policy to omit or postpone the official adoption by the Association of any name of this class and permit the problem to solve itself if possible by common usage of the names in question.

It is recommended that the list of names adopted at this meeting be included as heretofore in the Proceedings of the Association. A plan of publishing the list in uniform style, as additions are made from year to year, is suggested for consideration. This list, to properly serve its purpose, should be kept up to date and should be readily accessible to all writers on economic entomology.

The committee desires to thank the members who have shown an interest in the matter of common names for insects and expresses the desire that this interest will continue.

Respectfully submitted,
HERBERT OSBORN,
A. L. QUAINTANCE,
Committee.

LIST OF COMMON NAMES ADOPTED DECEMBER 28TH, 1909

Pomace fly	*Drosophila ampelophila* Loew.
Asparagus miner	*Agromyza simplex* Loew.
Beet leaf-hopper	*Eutettix tenella* Baker.
Coffee-bean weevil	*Aræcerus fasiculatus* DeGeer.
Sugar cane borer	*Diatræa saccharalis* Fab.
Cotton aphis (or Melon aphis)	*Aphis gossypii* Glover.
Cranberry spanworm	*Cleora pampinaria* Guen.
Citrus mealy bug	*Pseudococcus citri* Risso.
Diamond-back moth	*Plutella maculipennis* Curtis.
Elm span worm	*Ennomos subsignaria* Hbn.
False potato beetle	*Leptinotarsa juncta* Germ.
Grape colaspis	*Colaspis brunnea* Fab.
Green fruit worm	*Xylina antennata* Walker.
Greenhouse thrips	*Heliothrips hæmorrhoidalis* Bouché.
Hag moth	*Phobetron pithecium* S. and A.
Hop flea-beetle	*Psylliodes punctulata* Melsh.
Tobacco worm	*Phlegethontius quinque-maculatus* Haw.
Orange thrips	*Euthrips citri* Moulton.
Green peach aphis	*Myzus persicæ* Sulz.
Black peach aphis	*Myzus persicæ-niger* Smith.
Periodical cicada	*Tibicen septendecim* L.
Rocky mountain locust	*Melanoplus spretus* Uhl.
Flower thrips	*Euthrips tritici* Fitch.
Shot hole borer	*Scolytus rugulosus* Ratz.
Southern pine sawyer	*Monohammus titillator* Fab.
Striped garden caterpillar	*Mamestra legitima* Grote.
White marked tussock moth	*Hemerocampa leucostigma* S. and A.
Water-cress leaf beetle	*Phædon æruginosa* Suffr.
Water-cress sowbug	*Mancasellus brachyurus* Harger.
Western pine beetle	*Dendroctonus brevicomis* Lec.
Southwestern pine beetle	*Dendroctonus barberi* Hopk.
Roundheaded pine beetle	*Dendroctonus convexifrons* Hopk.
Southern pine beetle	*Dendroctonus frontalis* Zimm.
Arizona pine beetle	*Dendroctonus arizonicus* Hopk.
Smaller mexican pine beetle	*Dendroctonus mexicanus* Hopk.

Larger mexican pine beetle	*Dendroctonus parallelocollis* Chap.
Colorado pine beetle	*Dendroctonus approximatus* Dietz.
Mountain pine beetle	*Dendroctonus monticolæ* Hopk.
Black Hills beetle	*Dendroctonus ponderosæ* Hopk.
Jeffrey pine beetle	*Dendroctonus jeffreyi* Hopk.
Eastern larch beetle	*Dendroctonus simplex* Lec.
Douglas fir beetle	*Dendroctonus pseudotsugæ* Hopk.
Eastern spruce beetle	*Dendroctonus piceaperda* Hopk.
Engelmann spruce beetle	*Dendroctonus engelmanni* Hopk.
Alaska spruce beetle	*Dendroctonus borealis* Hopk.
Sitka spruce beetle	*Dendroctonus obesus* Mann.
Redwinged pine beetle	*Dendroctonus rufipennis* Kirby.
Lodgepole pine beetle	*Dendroctonus murrayanæ* Hopk.
Allegheny spruce beetle	*Dendroctonus punctatus* Lec.
European spruce beetle	*Dendroctonus micans* Kug.
Black turpentine beetle	*Dendroctonus terebrans* Oliv.
Red turpentine beetle	*Dendroctonus valens* Lec.

The report of the Committee on Testing Proprietary Insecticides was presented by Mr. E. D. Sanderson.

Mr. Sanderson stated that the main work that had been done by the committee had been an effort to secure a national insecticide law and that the progress in that direction had been reported in the last issue of the Journal of Economic Entomology. The prospects of the passage of such a law are very good and the matter will be taken up at the present session of Congress. He requested the support of the members in furthering this legislation.

Voted that the report be accepted and the committee continued.

Mr. Myron H. Swenk reported for Mr. Laurence Bruner, chairman of the Committee on Affiliation, that some progress had been made in this work, but that no further report could be submitted at this time.

By vote of the Association, the report was accepted as a report of progress, and the committee continued.

The President introduced Dr. C. W. Stiles of the United States Marine Hospital Service, who stated that he wished to call the attention of the Association to a movement which was being made to secure greater permanency for insect nomenclature. He stated that the matter was to be considered at the next meeting of the International Zoölogical Congress, next summer, and for the purpose of securing a list of accepted binominal names to submit to that meeting, he requested that as many zoölogists as possible forward to him a list of names which they considered authentic. These names are desired within the next three months, so that they can be edited, and from them a list will be selected for submittal to the meeting next summer.

The idea of this movement is to secure more stability in the nomen-

clature, and no one is expected to change the names accepted by the congress, without its approval.

Botanical as well as zoölogical names are desired.

It was suggested that a committee be appointed to take charge of this matter, and by vote of the Association it was referred to the Executive Committee.

The President appointed the following committees:

Nominations—S. A. Forbes, E. P. Felt and W. E. Hinds.

Resolutions—Franklin Sherman, Jr., C. P. Gillette and E. D. Sanderson.

Auditing—T. J. Headlee and E. L. Worsham.

Owing to the absence at the meeting of Mr. H. T. Fernald and Mr. W. D. Hunter, members of the Committee on Membership, the chair appointed Mr. H. E. Summers and the Secretary to fill the vacancies on the committee.

By a vote of the Association, the President was authorized to appoint a committee of three members to draft suitable memorial resolutions for the members who had died during the year, and Messrs. Herbert Osborn, C. R. Crosby and F. L. Washburn were appointed.

The Secretary read an invitation from Dr. Ludwig Von Graff, President of the Eighth International Zoölogical Congress, requesting that delegates be appointed to attend the meeting, which will be held at Gratz, Austria, from August 15th to 20th, 1910.

By vote of the Association, the matter was referred to the Executive Committee, with power to act.

A letter was read by the Secretary from Prof. H. A. Gossard, of Wooster, Ohio, expressing his regrets that he was not able to be present at the meeting, and bring with him the Ohio Exhibit of Insects, used for exhibition at state and county fairs. Owing to illness and other unexpected difficulties it was not possible to send the exhibit, but Professor Gossard promised to prepare a fully illustrated paper for the JOURNAL.

At four o'clock p. m., Wednesday, December 29th, the papers of the program having been disposed of, the final business of the session was transacted.

Mr. Sanderson suggested that some action be taken whereby at the next meeting members of the Association might be provided with a distinctive button, so that they could be readily distinguished from members of other affiliated societies present at the convention.

On motion, it was voted that the matter be referred to the Executive Committee, for its consideration, with power to act.

The report of the Auditing Committee was presented by Mr. T. J. Headlee, as follows:

REPORT OF THE AUDITING COMMITTEE

Your Auditing Committee for the 22nd annual meeting begs to report that it has carefully examined the accounts of your secretary, and found them in most satisfactory condition.

Respectfully submitted,

T. J. HEADLEE,
E. L. WORSHAM,
Committee.

By vote of the Association, the report was accepted.

President Britton stated that on account of a recent ruling made in the United States Department of Agriculture, it was not possible for members of the Association to secure their expenses when attending the annual meeting of this Association, and he suggested that some action should be taken to provide for the expenses of the Secretary at the meeting, and then presented the report of the Executive Committee, which is as follows:

REPORT OF EXECUTIVE COMMITTEE

In June this Association was invited by Sir William Ramsay to send a delegate to the International Congress of Applied Chemistry to be held in London, May 22d to June 2d, 1909. As it seemed desirable to have the Association represented and as we are not yet able financially to send a delegate so far and pay his expenses, your president asked Doctor Howard, who had planned a trip abroad, if he could not attend this meeting as a delegate. Finding this impracticable, one of our foreign members, Prof. A. E. Shipley of Cambridge, England, was asked to do so, and kindly represented the Association.

About the first of October the President was asked to appoint a delegate to represent the Association at the dedication of the new building of the College of Physicians at Philadelphia, November 10th. Dr. Henry Skinner was appointed, and kindly consented to be present.

On December 13th the President learned from Mr. W. L. W. Field of the plans to unveil during Convocation Week a tablet upon the site, in Milton, where Dr. T. W. Harris formerly lived. Mr. Field asked if he could be authorized to state that this Association would be represented at the unveiling. The authorization was gladly given, and Professor W. M. Wheeler was appointed to be present on that occasion as a representative of the Association.

The Executive Committee authorized the Secretary to expend money for the clerical work of the office to an amount not exceeding one half the unexpended balance of the previous year. This balance was $91.45. So far $15.50 has been used for this purpose. The committee further recommends

that for the coming year the Executive Committee be authorized to pay the Secretary such amount as it sees fit as a small honorarium.

Respectfully submitted,

W. E. Britton, *President.*
H. E. Summers, *Second Vice-President.*

By vote of the Association, the report was accepted and its recommendations adopted.

The report of the Committee on Resolutions was presented by Franklin Sherman, Jr., as follows:

REPORT OF COMMITTEE ON RESOLUTIONS

The committee on resolutions submits the following:

Resolved, That the American Association of Economic Entomologists hereby expresses its appreciation of the courtesies extended by the local committee on arrangements, the Cambridge Entomological Club, and the Corporation of Harvard University.

Resolved, That the thanks of the Association be tendered to the editorial management of the Journal of Economic Entomology for the excellent standard which they have maintained for the official organ of this Association.

Resolved, That we again declare our conviction that the control of the Gypsy Moth and the Brown-tail Moth in New England is an economic problem of the first magnitude, and of the most vital importance to the entire country. Furthermore, we would emphasize the importance of the several New England States and the United States Department of Agriculture continuing with undiminished vigor the policies so ably prosecuted during the past few years.

Resolved, That this Association urges upon Congress the necessity of legislation to provide for inspection to prevent the introduction of dangerous insects and plant diseases, and we recommend that this Association appoint as a committee Messrs. Symons, Worsham and Atwood to represent it in furthering such legislation.

Resolved, That we again endorse the bill now before Congress for the control of the purity of insecticides and fungicides (H. R. 2218).

Respectfully submitted,

Franklin Sherman, Jr.,
E. D. Sanderson,
C. P. Gillette,
Committee.

Voted that the report be accepted and its recommendations adopted.

The report of the Committee on Memorial Resolutions was presented by Mr. Herbert Osborn, as follows:

REPORT OF COMMITTEE ON MEMORIAL RESOLUTIONS

Your committee to prepare resolutions relative to the members of the society who had died during the past year, beg leave to report as follows:

Prof. M. V. SLINGERLAND, President of this Association in 1903, who died March 10th, 1909, had won for himself an enviable place among American Entomologists by the accuracy and originality of his observations and by the clearness and directness of his writings. As an Economic Entomologist, while insisting on absolute scientific accuracy, he never lost sight of the necessity of presenting the results of his studies in a form available for the public. He was an inspiring and sympathetic teacher and numbered as his friends all who had association with him. His untimely death is a distinct loss to Entomological Science.

By the death of Prof. B. H. GUILBEAU, the Society has lost one of its younger members who had already proved his ability as an investigator and teacher. His worth was generally recognized, and those of us who had the privilege of meeting him on the occasions when he attended our sessions were impressed with his qualities of earnestness, sincerity and friendliness.

In the death of Prof. A. GIARD, we recognize the loss of one of our most distinguished foreign members. His contributions to Economic Entomology have for many years been recognized as of special merit, and the Society feels that Entomological Science is deprived of an able exponent.

Resolved, That these resolutions be placed in the published records of this meeting of the society, and that copies be transmitted to the families of these deceased members with an expression of our sincere sympathy in their personal loss.

Respectfully submitted,

HERBERT OSBORN,
F. L. WASHBURN,
C. R. CROSBY,
Committee.

By vote of the Association, the resolutions were adopted.

The report on the Committee of Membership was read by Mr. J. B. Smith, as follows:

REPORT OF THE COMMITTEE ON MEMBERSHIP

Dr. L. O. Howard has nominated as foreign members: Prof. Nikolai M. Kulagin, of the Landwirtschaftliches Institut in Petrooskoje, Moscow,

Russia; Prof. G. Severin, Curator of the Natural History Museum in Brussels, and Prof. S. I. Kuwana, of the Imperial Agricultural Experiment Station of Japan, Nishigahara, Tokio, Japan.

The committee recommends that these persons be elected as foreign members.

The committee recommends for advancement from associate membership to the list of active members: Mr. C. T. Brues, Mr. C. R. Crosby, Mr. J. J. Davis, Mr. H. J. Franklin, Mr. A. G. Hammar, Mr. E. F. Hitchings, Mr. Fred Johnson, Mr. A. D. MacGillivray, Mr. H. M. Russell, Mr. M. H. Swenk, Mr. O. H. Sweezey, Mr. J. L. Webb and Mr. W. W. Yothers.

Your committee recommends the transfer from the foreign membership list to the list of active members of Dr. C. Gordon Hewitt, of the Central Experiment Farms, Ottawa, Canada.

Dr. W. B. Alwood has presented his resignation as member of the Association to the Secretary, and your committee recommends its acceptance.

The following names are presented for associate membership:

Arthur I. Bourne, Bureau of Entomology, Washington, D. C.
Lawson Caesar, Guelph, Ontario, Canada.
S. C. Clapp, Department of Agriculture, Raleigh, N. C.
Wesley R. Coe, New Haven, Conn.
C. W. Collins, Gypsy Moth Parasite Laboratory, Melrose Highlands, Mass.
Samuel S. Crossman, Orlando, Fla.
Wm. E. Evans, Jr., Painesville, Ohio.
Edward R. Farrar, South Lincoln, Mass.
Warren S. Fisher, Highspire, Pa.
S. W. Foster, Bureau of Entomology, Washington, D. C.
C. B. Hardenberg, Bureau of Entomology, Washington, D. C.
R. W. Harned, Agricultural College of Mississippi.
William B. Herms, University of California, Berkeley, Cal.
P. H. Hertzog, Lewisburg, Pa.
G. H. Hollister, Hartford, Conn
O. A. Johannsen, Orono, Maine.
F. A. Johnston, Amherst, Mass.
Nathaniel T. Kidder, Milton, Mass.
Joseph H. Merrill, Danvers, Mass.
Z. P. Metcalf, Raleigh, N. C.
Albert P. Morse, Wellesley, Mass.
W. C. O'Kane, Durham, N. H.
John R. Parker, Amherst, Mass.
E. E. Philbrook, Portland, Maine.
Asa O. Pike, Springvale, Maine.
Edw. P. Ripley, Weston, Mass.
T. E. Snyder, Bureau of Entomology, Washington, D. C.
A. M. G. Soule, York Village, Maine.
John N. Summers, Amherst, Mass.
William R. Thompson, Melrose Highlands, Mass.
Philip H. Timberlake, Melrose Highlands, Mass.
William R. Walton, Harrisburg, Pa.
R. D. Whitmarsh, Amherst, Mass.

V. L. Wildermuth, Bureau of Entomology, Washington, D. C.

L. H. Worthley, Boston, Mass.

James F. Zimmer, Bureau of Entomology, Washington, D. C.

Nine active members are in arrears for dues for three years, and the committee recommends that the Secretary notify these members of their delinquency. If within three months they have not paid the full amount due, the Secretary is instructed to strike their names from the list of members.

Ten associate members are in arrears for dues, three years, and the committee recommends the same action.

Respectfully submitted,
JOHN B. SMITH,
H. E. SUMMERS,
A. F. BURGESS,
Committee.

By vote of the Association, the report was accepted and its recommendations adopted.

The report of the Nominating Committee was read by Mr. E. P. Felt, as follows:

REPORT OF THE NOMINATING COMMITTEE

The committee submit the following nominations:

President, E. D. Sanderson, Durham, N. H.

First Vice-President, H. T. Fernald, Amherst, Mass.

Second Vice-President, P. J. Parrott, Geneva, N. Y.

Member of Committee on Nomenclature, H. Garman.

Members of the Advisory Board of the JOURNAL OF ECONOMIC ENTOMOLOGY, C. P. Gillette, Fort Collins, Colo., and Wilmon Newell, Baton Rouge, La.

Councillors for the American Association for the Advancement of Science S. A. Forbes and H. E. Summers.

Respectfully submitted,
S. A. FORBES,
E. P. FELT,
W. E. HINDS,
Committee.

By vote of the Association, the Secretary was instructed to cast a ballot in favor of the members named in the report as officers for the ensuing year.

It was also voted that the time and place for holding the next meeting be referred to the Executive Committee, with power to act.

The Secretary announced that on the following morning an excursion would be made to Arlington to witness a spraying demonstration at the office of Messrs. H. L. Frost & Co.[1]

There being no further business, the meeting adjourned.

[1] Thursday morning, December 30th, 1909.—About 25 members were pres-

PART II

The address of President W. E. Britton was presented at the opening session Tuesday morning, with Second Vice-President Summers in the chair, and was as follows:

THE OFFICIAL ENTOMOLOGIST AND THE FARMER

By W. E. Britton, *New Haven, Conn.*

It is with hesitating steps that I attempt to follow the path, at first but a trail, blazed by the pioneers of American Economic Entomology, and later trodden by their followers, so illustrious—some of whom are no longer with us. That path is now a well-worn thoroughfare. Seemingly little grain can be left along its borders, so many careful workers have gleaned by the wayside.

In looking over the list of subjects treated in the addresses of former presidents of this Association, I find that almost every phase of Economic Entomology has been ably discussed, but conditions are ever changing, and it remains for me to call your attention to a few present aspects of the subject, and to leave with you a few somewhat disconnected thoughts regarding them.

My subject, "The Official Entomologist and the Farmer," needs perhaps a word of explanation. By "official entomologist" I mean such men as are employed by the various states and territories and by the Federal Government to study insects and their relations to man and his crops. It includes state entomologists, state nursery inspectors, commissioners in charge of suppressing certain important pests, experiment station entomologists, professors of entomology in agricultural and other colleges, and members of the working staff of the Bureau of Entomology at Washington. Certain museum curators also might well be included under the term. It may be assumed at the out-

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ent at the demonstration, as guests of Mr. H. L. Frost, and after examining his office and extensive storehouse, containing all kinds of insecticide machinery, the demonstration was held. A high power gasolene sprayer was used, and the members had an opportunity to observe the solid stream system of spraying.

Several new devices, in the way of couplings, nozzles, etc., were also on exhibition.

All those present expressed much satisfaction in having had an opportunity to be present at the demonstration, and a vote of thanks was extended to Mr. Frost for his courtesy and hospitality.

set that the official entomologist is an economic entomologist, because men are not usually employed by nations, states, or even universities and colleges to investigate the purely scientific aspects of entomology. Such an official, therefore, is supposed to be in readiness to impart information at all times and places regarding insects and their injury, and how to suppress them.

For the purpose of this discussion we should not limit the term "farmer" to the man who tills the soil as his chief business, but should rather give it a broader interpretation and make it include the "gentleman farmer" and the resident of the village and city; in fact, anyone and everyone who can be helped by the official entomologist or who seeks his aid. In other words, the title might read, "The Official Entomologist and His Constituency."

What are the qualifications of a model official entomologist? For the first essentials we can probably do no better than to quote from Mr. F. M. Webster's excellent paper before this Association at the Baltimore meeting a year ago in regard to the requisites of an assistant.

"With all of us who have the management of men there comes a time when an emergency arises and someone must be detailed to a most difficult piece of investigation, where only the most resourceful, persevering and trustworthy are to be employed, and lucky is the man who gets the opportunity. Now if I were to be asked to indicate some of the most essential qualifications for such a man I should say, first, honesty, and, second, common sense."[1]

Let us adopt these qualifications as being the two most important ones also for the official entomologist. Indeed, lacking them he can never be a real success in this or any other profession. The importance of training should not be overlooked, and right here let me say that many, perhaps most, of us have gone into our work and our positions with very scanty training. In fact, the great demand for workers during the past few years has necessitated the acceptance of many otherwise excellent men who are not sufficiently trained in entomological methods and technique. This cannot be helped, and in such cases the men must get their training through actual experience in their work, which is perhaps after all the best school. If these men have honesty, common sense, energy and a little ingenuity, or resourcefulness, they will soon outstrip others who have had far better training in whom these qualities are lacking.

The entomologist must do something more than gather facts; he

[1] Journal of Economic Entomology, Vol. II, p. 99, April, 1909.

must be able to interpret their meaning. He cannot always be in his office or laboratory, even though it is a great convenience to his people to find him when they call. He cannot always be in the field, but he should have a thorough knowledge of the conditions there. In fact, he should have a good general knowledge of all phases of his subject, and it is desirable that he be a specialist and an authority in a few of them.

Probably few of us possess all qualifications necessary to make us ideal official entomologists. Perhaps everyone has some of them. As his work increases, he must have help,—and if funds are available, scientific and clerical assistants are secured. He must then plan and direct their efforts as well as his own. He must possess tact, must be a good organizer, and must be able to judge the ability and capacity for work in others. He must be able to manage men. New problems are then introduced in regard to the proper credit for work done by his assistants. The ideal official should err on the side of generosity rather than that of selfishness in such matters. It is true that the assistants can usually do much of the routine work where no credit is expected or given in publication.

In his relations with other entomologists he must be courteous, and give credit where credit is due. He should refrain from engaging in personal controversies, though he should not hesitate to stand up for the right as he sees it.

Too many of us have our attention occupied by work of a routine nature because of a lack of help. It is extremely important that the entomologist be given some time for research work in order that he may aid in increasing the sum total of human knowledge in his chosen subject. There are still many problems to be solved, and the official entomologist from his wealth of experience and observations can survey the field with a broader view than the beginner. Unfortunately, in many cases the official has little time for investigation and whatever is done must be done by assistants. At any rate, some research work should be done.

To gain knowledge through observation and research is clearly the first essential of the profession. The second essential is to bring this knowledge before the public. And let me say that right here is one of the problems of the official entomologist as well as of every experiment station worker. The most intelligent farmers, and a certain number of merchants, manufacturers and employees, as well as scientists, are always in touch with such work and often aid the official in it. But there is always a great mass of people who have never heard of the state entomologist or of the agricultural experiment station of

their own state, and who are entirely ignorant of all such matters. They must be informed. I say *must* because their own welfare and the public interests are at stake. The public health demands it. Health officers and medical men are now calling upon official entomologists for expert evidence and advice about the breeding places of mosquitoes and flies, and this support should be given them wherever possible. Ignorance of the law—man's law—excuses no one; but in ignorance of nature's laws our greatest dangers lie. The comparatively recent discoveries of the spread of human diseases by insects make it imperative that no opportunity be neglected to place the proper instruction regarding entomological sanitation before the people. This should be done, however, in a dignified way, and the commonest method is by means of publications. Lectures, illustrated by lantern slides and by insect specimens, are also an important means of getting the facts before the people. The press is our most powerful ally, but the modest entomologist shrinks from the publicity acquired if he is interviewed too often by the reporter, and also hesitates to send information to the papers. Perhaps some of this publicity can be avoided if the information is given out as coming from the institution instead of from any particular individual connected with it.

I believe that educational exhibits at fairs and agricultural meetings are of the greatest value in educating the people. They should be arranged in an attractive manner, and supplied with neat descriptive labels that give real information. In an exhibit of this kind at a Connecticut fair in September, twenty cages of living insects attracted more attention and excited more interest than any other portion of the exhibit. The living insects shown included mosquitoes, both *Anopheles* and *Culex,* in larval, pupal and adult stages, and a number of caterpillars, which could be readily procured at that time of the year, most of them being common pests of the field or garden.

We should avoid the vaudeville methods practiced by some zealous workers for the betterment of mankind. Dignity and good taste should be maintained, or we had better dispense altogether with this means of educating the public.

In order to do effective work, an official entomologist must have the confidence of his clientele. It is not always easy to gain this confidence. Personal contact with the farmer, honesty and frankness regarding entomological matters, and prompt attention to the details of each inquiry will help much. It is always better to say "I don't know," if that indeed be the truth, than to allow the farmer to learn that fact from some other source.

I have given some of the requirements of the ideal official entomologist. Few of us, I fear, can meet them. Nevertheless, in spite of all his shortcomings, the official entomologist is often of great practical value to the state. For instance, in case of a local outbreak of a serious insect, if there is an authorized entomologist with forces already organized and a small fund at his disposal, the pest may be not only kept from spreading, but perhaps actually exterminated in that locality, thus saving great losses of crops as well as tremendous expenditures of money to later subdue the pest and get it under control, if that is even possible.

The experience of the New England states with the gypsy moth, *Porthetria dispar* Linn., and the shipment into this country of nests of the brown-tail moth, *Euproctis chrysorrhœa* Fabr., on nursery stock last year, in the absence of any system of Federal inspection, would seem to make it not only expedient but almost necessary for the safety of property and other interests, that each state not having such a department should at once organize one. An instance from my own state will serve as an example: On December 14th, 1909, I learned that the gypsy moth had been reported from the town of Wallingford. That very day we verified the report, and the following day had men at work destroying the egg-masses, getting 2,000 the first day. Since then the work has been continued, and over 5,000 egg-masses have been destroyed. The infestation is a bad one, covering at least three quarters of a square mile, but the pest must be exterminated. It is needless to say that any prompt and effective suppressive measures would be out of the question in a state without funds available for the purpose and an organized entomological force ready to act.

There are still many farmers in each state who have never heard of their own agricultural experiment station or even of the Federal Department of Agriculture,—but their number is growing less and less—and these institutions are now more firmly entrenched in the minds and the work and lives of the people than ever before. The taxpayer may have borers in his squash vines, San José scale on his fruit trees, or lice on his cattle; he likes to have some central bureau of the state or Federal government where he can apply for information entomological and feel that he will receive the best of advice.

Having just mentioned some of the qualifications of the official entomologist and the proper development of his department for efficient service, it now behooves me to say a few words about the ideal farmer, or member of the entomologist's constituency. He is often a hard working man, with little time for study, and his interest has never been aroused in the living things around him. He is too often

bent on "making both ends meet." The most intelligent are usually ready and willing to aid the entomologist by furnishing information about the prevalence of certain insects, and report regularly to him. They take their teams at a busy season and drive him around the neighborhood in order that he may get a better idea of conditions prevailing there. Coöperative experiments are arranged and often carried out faithfully, to the advantage of both owner and experimenter.

Occasionally we have experiences similar to that of an experiment station botanist who had conducted a coöperative experiment on the grounds of a truck grower to test the efficiency of sulphur treatment to prevent celery leaf blight. The treated plants promised well, and one day he visited the place to make final notes in the field before the crop was harvested. Before reaching the field he saw the owner, and, asking him about the celery, was disappointed to learn that it had just been dug. "Oh, that is too bad," said he. "Well, I don't think so," remarked the owner, with a laugh; "I got two dollars a crate for it."

But most farmers are willing to do the fair thing when they know that the entomologist is working for a small salary to learn truths which may benefit them. I have known them to greatly inconvenience themselves in order to give him ample facilities for conducting experiments, the results of which were of no particular benefit to them, or at least not more so than to other farmers.

Of course it must be expected that the farmer will be more interested in the practical results of the experiments than he will be in any scientific value which they may possess, yet many farmers have a full realization of the necessity of a careful study of an organism to determine its life history as a means to an end—practical methods for its control.

We all find it difficult at times to answer the questions put to us by some of the growers, and their shrewdness is often amusing. I have known a correspondent to send insect specimens to his own experiment station for identification and at the same time send duplicate lots to a similar institution in another state and to the Bureau of Entomology at Washington. If the replies all coincide, presumably he gets the right name for the insect.

A further consideration of the matter only makes it more evident that the official entomologist in order to be efficient in his helpfulness to the farmer should do something more than write long-range prescriptions. He can go to the field occasionally, view the conditions, and will then probably prescribe differently and more to the purpose.

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The farmer will know him better and will soon have more confidence in him.

The entomologist, too, will have more respect for the farmer and his methods, and more interest in him and his particular problems because of the contact. It will prove mutually advantageous.

The literature of economic entomology has been discussed several times in the meetings of this Association, but I wish to mention it here on account of its bearing upon my subject. Some official entomologists publish annual reports. Others publish in the reports of the institutions with which they are connected, and such reports appear to be a fit place to publish the full accounts of any experiments or investigations, or descriptions of methods and technique. Descriptions of new species or important facts regarding the life history or habits of an insect should be published in monographic treatises or in entomological journals. These publications are of great service to other workers, but do not as a rule appeal to the popular mind, especially if somewhat technical in their nature.

The popular bulletin or circular fills a distinct place in the list of publications of any official entomologist or experiment station worker —and I believe this has been conceded by those who have previously discussed the matter. Such a bulletin should give a brief, concise, non-technical account of the insect and directions for its control. Though we can place no definite limits as to the size of such a bulletin or circular, in general it should be brief. Often all that it needs to contain can be told in four or six, and seldom requires more than twenty-four pages. If very long, it should be provided with a table of contents and a brief summary. Illustrations are of the utmost importance in the popular bulletin, but they should be good ones. Photographs of insect injury are usually better than drawings, and the larger species can be shown very well in photographic illustrations. There are many details, however, that can be shown only by drawings, and zinc cuts are often used for all the illustrations.

Such a bulletin as I have mentioned is usually sent to all names on the mailing list. But there is frequently a demand for another form of imparting information, and some experiment stations issue special bulletins or circulars either to convey brief, timely information or to assist in the correspondence. Several forms of these have been given a trial at the Connecticut Station at New Haven. For instance, aside from our numbered series of reports and bulletins, we issue occasionally the "Bulletin of Immediate Information," which is mailed, not to the names on the regular list, but to a certain class, such as fruit growers, truck growers, dairymen, or nurserymen. This

publication is supposed to contain timely information not important enough or of enough permanent value to go as a regular bulletin. Like the other bulletins and reports, it requires a special wrapper for mailing, and can be sent out under the usual frank. We have also used for the same purpose the "postal card bulletin" for short articles of timely information. These are printed on postal card stock 4 x 7 inches in size, with the frank and space for the address on one side and the printed message, with possible illustrations, on the other.

These publications all have their place, and are of value in imparting timely information, and are of great convenience to the official entomologist as an aid in answering his letters. But none of them can be sent out in quantity without a mailing list and considerable work in addressing envelopes.

During the past summer another method has been tried which has long been in use by advertisers. We call it the "correspondence slip" or "dodger," and it consists of a single sheet of paper of the proper size to go into the letter envelope without folding. It may be printed on one or both sides, and is adapted for only very brief messages. Where possible a characteristic illustration is used in one corner, and perhaps the seal of the institution in another. These slips are not mailed to any list of names, but are simply placed in all the letters sent out from all departments of the institution at the time when the information will do the most good. They are also enclosed at other times, when the correspondent needs the message which they bear. In this way they reach many names not on the regular mailing list, and serve the purpose of calling attention to the work of the institution perhaps outside of the particular subject of the letter, and also outside of the department where the letter was written. They bear no date, and therefore are just as good a year hence as today, provided there has been no change in our knowledge of the facts or of the best method of treatment. So far only six of these slips have been prepared, and each has been printed on a different color of paper, but of course the list of tints would soon be exhausted. Press bulletins are also in vogue at some institutions, and serve their purpose admirably.

I realize, however, that many entomologists through no fault of their own are unable to bring forth publications that could be considered as ideal or even satisfactory. The plans are made by others higher in authority, and the rules of the institution prevent the entomologist from carrying out his own wishes and ideas. Perhaps there are scanty funds for publishing; or so much attention is required in teaching that there is no time for anything else. Such conditions, of course, are to be deeply regretted.

Fellow-members, it is truly a matter of congratulation that we now have so many young and earnest workers in the field of entomological research, and each one doing the best he can. There are many problems yet unsolved. Let every worker rejoice in the opportunity. There is a chance for each to contribute his full share in the days to come, for the good of the whole race.

The next paper on the program was entitled "A First Course in Economic Entomology," by F. B. Lowe, Detroit, Mich.

A FIRST COURSE IN ECONOMIC ENTOMOLOGY

By F. B. Lowe, *Detroit, Mich.*

[Withdrawn for publication elsewhere.]

At the close of this paper, the session adjourned.

Afternoon Session, Tuesday, December 28th, 1909.

The meeting was called to order at 1.15 p. m. by President Britton, who called Second Vice-President Summers to the chair.

Chairman Summers: The next thing on the program will be the discussion of the presidential address.

Mr. Sanderson: All of us certainly appreciate and are in full sympathy with the remarks of our President made this morning concerning our relation to the farmer. One of the greatest factors in securing the application of the methods of insect control devised by the entomologist is in the entomologist keeping in touch with the farmer and putting himself on the farmer's level so that he can appreciate his viewpoint and can make such suggestions as will appeal to the farmer. One of the greatest aids in this work is the actual demonstration of the methods advised in the field. Where these methods are used, it is wonderful how readily many farmers will take up new methods. I remember when the first work was done on the boll weevil in Texas and we felt that it would be some time before we could secure the adoption of the methods devised by the planters, but owing to the demonstrations which were carried on thruout the state, it was but a few years before the method of cotton growing was largely revolutionized. It makes but little difference whether one is working in the West or in the East, the North or the South, if the farmer is approached in this way. When I commenced an agitation for spray-

ing in New Hampshire four or five years ago I thought it would be many years before any large number of our farmers would be spraying their orchards, but during the last year there were over 400 who did so. That is a small number, but the state is small, and it shows a tremendous progress in a few years.

Mr. Hitchings: Our President referred to the exhibits made at the fairs and similar associations in the state, and I think that this is a very important factor in our work, as by such exhibitions we come in contact with many farmers. In the past two years, however, we have had so many demands in this line that we could not attend to all of them.

Mr. Felt: I wish to express my personal pleasure and gratification at the address delivered by our President this morning. I think, in reference to circular letters, however, that these should be used with discretion. In New York state, I fear the recipient of such a letter would pay undue attention to things which are not of primary importance. I prefer to deal directly with the local conditions of the correspondent.

A Member: We do not as a matter of practice use circular letters, but I recognize the practicability of giving certain information in that way. I believe our experience has justified this, and of course in certain instances I feel it is better to give the information desired, and not allow the recipient to draw his conclusions, according to his own understanding of the matter.

A Member: I think that point of Doctor Felt's will appeal to some who receive circular letters. If a question is asked one of our inspectors, and the man receives a letter, he will appreciate it very much more, and will take advantage of the suggestions made much more often, than if a brief letter is written him, and a circular tucked in. In some cases it might be better to write a few more letters and give more detail to the man who applies for information, rather than send out a great number of circular letters that would never be read.

Mr. Headlee: We think that it is a great mistake to send all publications to every member of our mailing list. A man who opens a large number of franked envelopes and finds nothing of value is likely to develop the habit of throwing such matter unopened into the waste basket. In fact, I think that this habit is now so well fixed in certain quarters that to insure especially important information reaching the person for whom it is intended it is necessary to enclose it in a regular two-cent envelope. The mailing list should be so revised for each mailing that the information will always be sent where needed.

Mr. Hewitt: I wish to thank our President for his very excellent

and suggestive remarks, and I would also like to add my experience to that of Doctor Felt. I think that the entomologist should in all cases coöperate with the farmer or fruit grower, as the case may be. By distributing circular letters in this way, you are liable to be treated with scant courtesy, whereas if you send a man a letter, if only a few lines, you will be able to deal with his particular case, and he will be more likely to reply to your letter.

I do think we can hardly be too careful about our correspondents, as to the results obtained by carrying out our recommendations. I always endeavor to ask the correspondent to kindly give me the results of the application or the suggestions.

In regard to the distribution broadcast of these circulars, take an extensive country like Canada, where you have entirely different conditions to meet in Quebec, in Ontario, and in British Columbia, and you will see that it is impossible to deal with these widely separated provinces by a circular letter, giving the same remedial measures, and although in some cases a very large correspondence may be entailed, I find it is better for ourselves and for the correspondent if we pay as much personal attention to his inquiries as possible.

I am sure we have all been deeply interested in the points which our President raised, and I should like again to thank him.

President Britton: I might say here that it was not my intention to suggest that circular letters be used entirely; but it is a question whether we should spend so much time in copying over and over again formulæ for making Kerosene Emulsion and Arsenate of Lead, or whether it would not be better to have these formulæ printed and include one with a personal letter.

Mr. Washburn: The entomologist can, of course, tell whether he is successful in using this printed matter. Our experience in Minnesota is to send the advice to a farmer, and that is the end of it. They might possibly tell us the results of this advice, if we were to write for it, as suggested by Mr. Hewitt. Most of the farmers will not take the time or trouble to write.

Mr. Hewitt: In reply to Professor Washburn, I have unfortunately had only about three months' actual experience in Canada, but in the old country, where I had a wide correspondence with the farmers and others, they were always willing to coöperate with the entomologist, and in Canada I have found on the part of the more educated farmers men who are willing and interested enough to inform me of the results of the experiments.

Mr. Parrott: All I wish to say is that I am thoroughly in accord with our President's views. The entomologist's correspondence is

rapidly increasing and we find in our own experience that printed circulars very much simplify the work of correspondence. We employ the leaflets to supplement our letters.

Mr. Sanderson: The idea of following up a letter at the proper time with another one to ascertain whether the advice or suggestions have been followed out has appealed to me, but I have not been able to definitely prove the value of such a scheme when carried out systematically. At our station we have adopted the scheme of making a card record of all inquiries of correspondents by the subjects of their inquiries. There is cross reference to another card catalog arranged by post offices. This enables us at any time to refer to all of the inquiries we have had upon any one of the leading subjects upon which we have frequent inquiries. It has been my feeling that if occasionally we could send a letter to these parties asking whether they had followed out our suggestions and if so what the results were, that we would find that in many cases the suggestions had not been properly carried out and only partial success or failure had resulted. This would be brought out by such correspondence and the correspondent could be advised as to his trouble. Thus failure which would be blamed on the station might many times be prevented. This is simply the application of the methods used by every business office to the work of station correspondence, and altho possibly it should come under the work of an extension department rather than that of an experiment station, it seems to me that it is highly desirable that some such scheme be carried out.

Mr. Walden: The timely information slips are prepared just in advance of the proper time to combat the insect or disease to which the slip refers, and are distributed among the different departments of the Station to be inserted in all correspondence. For example, a man may write to the Station inquiring about fertilizers; the chemical department will reply to this letter and enclose a slip regarding, perhaps, the canker worm. The man may be interested in this matter, and if the slip does not contain sufficient information will write to the entomological department for more detailed instructions.

We have in this way received inquiries from men who perhaps were not familiar with work of our department, and I think we get in touch with more people through these slips that we could in the ordinary way.

At 1.45 p. m. President Britton resumed the chair and called for the next paper on the program, which was read by Mr. E. P. Felt, Albany, N. Y., as follows:

OBSERVATIONS ON THE HOUSE-FLY

By E. P. Felt, *Albany, N. Y.*

An attempt was made the past season to obtain accurate data respecting this insect's behavior toward light. The principal object of the experiment was to determine the possibility of storing manure and other substances in which this pest breeds, in dark or nearly dark cellars or compartments.

Outline of Conditions. A fly vivarium was located in the writer's back yard (a typical village lot) at Nassau, Rensselaer County, N. Y. This building was a nearly light-proof structure 6 x 10 feet in outside dimensions and with a height of 6 feet 4 inches in front and 5 feet 6 inches in the back. To facilitate the location of materials, etc., the spaces between the joists were numbered consecutively, beginning at

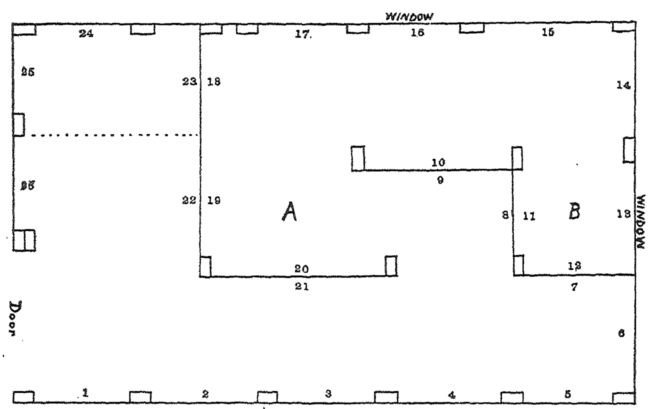

Fig. 1. Plan of fly vivarium (original).

the door on the north wall and running around and including in the enumeration the spaces of the partitions as well as the outside wall (Fig. 1). A light-proof window (18 x 18 inches) was made in the south wall near the southwest corner (at station 16) and another in the west wall (at station 13). Light-proof partitions, arranged somewhat like those in a photographer's dark room, divided the interior (Fig. 1) in such a manner that there was a constant decrease in the light as one progressed from the door back through the partitions and around to the darkest corner near the middle of the south end (station 12). Ventilators were provided in the roof at A and B (Fig. 1). There is in the southeast corner, at station 23, a small closet 21 inches deep and 3 feet above the ground. The interior of the building was painted a dull black the latter part of April. The door located at the

northwest corner is 26½ inches wide and 71¼ inches high. This door was allowed to remain open throughout the season, and the entrance of animals or children prevented by the use of a coarsely screened (½-inch mesh) door having an interior clear space of 23 x 67 inches. The building was so situated that August 24, at 8 a. m., rays of the sun reached back to the base of the corner of station 8 and a little later in the day would extend to the base of the pail at station 6. There was sufficient illumination under these conditions at station 18 so that one experienced little difficulty in discerning objects located there. Mackerel kits containing horse manure thoroughly sterilized by steam were placed at stations 6, 12, 18 and 23. The vivarium was located about 20 feet from one barn where a horse was kept, the manure from the animal being thrown outdoors. There was another barn, where at least two animals were kept throughout the summer about 40 feet away to the southwest and another barn about 50 feet due east. This latter had been occupied in previous years by six to eight horses, and when the vivarium was constructed it was expected that an equal number of animals would be kept in the building throughout the summer. Owing to a change of plans but one horse was kept in this barn, and as a partial result of this change there have been considerably fewer flies than in previous years. Furthermore, the excessively cool weather continuing well into June greatly delayed the appearance of the house-fly in numbers. Relatively cool weather continuing throughout the summer has also served to prevent rapid breeding. This combination of causes has resulted in house-flies being much scarcer than usual.

Experiments. House-flies were becoming somewhat abundant June 23d and operations were commenced by placing mackerel kits nearly filled with sterilized horse manure, at stations (see numbers on figure) 6, 12, 18 and 23. House-flies becoming more abundant the latter part of July, another set of pails with horse manure was placed at the stations indicated above and, in addition, one just outside the door. Rather abundant rains kept the last named pail nearly full of water, and numerous Muscid larvæ were observed in the contents the remainder of the season. House-flies entered the vivarium freely, being rather numerous at station 23 and frequently working back to station 6. Muscid larvæ were in pails at both of these stations and one, which may possibly have been a Musca, at station 12. Fruit flies, Drosophila species, were observed in numbers July 21 at station 6, evidently being drawn in part by swill placed there for the purpose of attracting flies. This species was very numerous about the pail, alighting in numbers on the walls above, but scarcely penetrating into the darker portions

of the vivarium. *Psychoda alternata* was relatively abundant in midsummer about stations 23, 6 and less so at station 12. Toward the end of the season some were observed at station 18. This latter occurrence may possibly be explained by a mouse burrow admitting a small amount of light in the near vicinity of the pail.

Conclusions. The above data, while not so conclusive as could be desired, show that the house or typhoid fly does not breed freely in darkness. This pest exhibits a decided preference for sloppy filth in light places. It is practical and thoroughly in accord with the best agricultural practice to either draw out and spread manure at frequent intervals, or to store it in cellars or sheds. The relatively cheap cement underpinning makes it comparatively easy to construct dark cellars, places where manure or other fly-breeding material can be kept without producing swarms of flies. These measures, while particularly adapted to the farm, will also prove of service in villages and cities.

Mr. Hewitt: As one who has been working on this question for some years, I should like to thank Doctor Felt for his interesting paper. I have found my own observations exactly coincide with those of Doctor Felt; that is, that flies breed more abundantly under bright conditions than in dark places, although the flies crawl down into the dark crevices to deposit their eggs.

A Member: Will not flies oviposit in the manure before it can be removed to the dark cellar or pit?

Mr. Felt: I think it makes no particular difference whether the eggs are deposited in the manure or not, since, if there is considerable breeding, it is comparatively easy to arrange a light though flyproof trap which would attract the flies and prevent the insects escaping from the manure cellars or pits.

Mr. Cooley: I would like to ask whether the temperature interferes in any way. Was the house as warm as the area outside?

Mr. Felt: If Professor Cooley could have entered the fly vivarium, he would have agreed that the flies had a pretty warm reception. It was quite warm at times. The house is standing, and will probably be used another year.

President Britton: The next paper on the program will be read by Professor Sanderson, Durham, N. H.

CONTROLLING THE BLACK FLY IN THE WHITE MOUNTAINS

By E. Dwight Sanderson, *Durham, N. H.*

In 1904[1] Dr. C. M. Weed showed that the larvæ of the black fly might be destroyed by an application of phinotas oil and later Mr. A. F. Conradi, who performed the experiments, gave a further report.[2] The experiments at Dixville Notch conducted at that time were entirely successful, and but very little trouble has been experienced from black flies in that locality since then.

For the past few seasons the residents at Appalachia in the valley immediately north of the Presidential Range, have been greatly annoyed by the black flies and appealed to us for some practical means of controlling the pest. It was found that the neighboring streams were alive with the larvæ, and in view of the previous experiments it seemed entirely feasible to destroy them by the use of phinotas oil. My assistant, Mr. W. M. Barrows, spent the greater part of the month of July at Appalachia investigating the habits of the flies and in making experiments for their control. Two species occur commonly, the white legged variety (*Simulium venustum*) causing very little annoyance, the biting being done by *Simulium hirtipes.* The life history of these species is unknown in this region. There is a general belief among the inhabitants that the flies are to be found over winter in the timber, and reliable observations are given us of parties being troubled by the biting of the black flies high up on the mountains the second of October after there had been a heavy snow and frost in the valley. It has been supposed by some observers that the small larvæ passed the winter on the stones; in any event the flies are more numerous during early summer and again in later summer. In early July we found but few young larvæ and were unable to find the eggs, most of the larvæ being full grown and pupating. By the middle of July many flies were emerging from the pupæ. It is evident that if the flies hibernate they would be unable to deposit their eggs until after the high water of spring subsided. An accurate knowledge of the life history of the insect will be absolutely necessary in order to determine the best season for carrying on measures of control by oiling and will probably also have an important relation to the effect of the oil on the fish.

It was found that phinotas oil applied to the stream by throwing it

[1] Bulletin 112, N. H. Agr. Experiment Station.

[2] See Bulletin 52, Div. of Entomology, U. S. Department of Agriculture.

out with a cup in the rapids by a man wading down stream would destroy the larvæ effectively. The larvæ are found almost entirely on the rocks where the water flows over them very swiftly and breaks into rapids or spray. Rocks in smooth running water have very few larvæ upon them. In the preliminary experiments a net was stretched across the Moose River, a small stream 10 to 20 feet wide, and the water was oiled for a distance of 100 yards above the net. The man applying the oil can walk nearly as fast as it floats down stream and the fish descend the stream ahead of the oil. Where the fish were caught in the net many of them were overcome by the oil, but as it passed on and the water cleared up within 15 or 20 minutes, all revived and showed no subsequent ill effects. This experiment was repeated three times in which individual fish were overcome each time, but survived with no ill effect.

After these experiments it was determined to oil a considerable stretch of the stream, which was done in the same way. This application was entirely effective in destroying the larvæ, but unfortunately it resulted in killing a considerable number of the fish, due to the fact that the volume of oil was such that the fish descending the stream with it were subjected to it for too long a time. From our previous experiments we feel certain that had nets been stretched across the stream so as to catch the fish and so that they would not have been subjected to the oil for over 15 or 20 minutes, no trouble of this kind would have ensued. Our observations also lead us to the opinion that the oil might be applied much more economically by the use of a knapsack sprayer and a nozzle, preferably a Bordeaux nozzle, by which the oil could be applied directly to the worst affected rocks in a spray which could be directed immediately on them. This would use much less oil and would consequently have less effect on the fish. The method of merely throwing the oil in the stream with a cup forms an emulsion of the whole volume of water in the stream. The oiling was carried on both in the river, which has a gradual fall, and also in Cold Brook, which descends the mountain side very rapidly over large stones as shown in plate 2. The application was equally effective under both conditions. The numbers and position of the larvæ on the large stones in Cold Brook are indicated by plate 3, in which they are somewhat indistinct owing to an inch or two of water flowing over them.

From these experiments and observations we are led to believe that the destruction of black flies in the resort regions of our mountains is entirely as feasible as the control of mosquitoes in low country such as the vicinity of New York and New Jersey. To work out practical

Scene on Cold Brook Showing Rocks Seen in Plate 3

Rock in Cold Brook Covered with Black Fly Larvæ

methods will involve an accurate knowledge of the life history of the flies and of their ecology, and experiments to determine the effect of the oil on fish as applied at different times and by different methods. We hope to be able to carry on such investigations in the future, but as such work involves considerable expense, for which we have no funds definitely appropriated, the completion of the work may not be possible in the near future, so that it would seem well to call the attention of others to the work, since they may have a chance to give it the requisite study.

PRESIDENT BRITTON: We will now listen to a paper by Prof. C. P. Gillette, Fort Collins, Col., on "A New Arsenical Poison for the Codling Moth."

NEW SPRAYS FOR THE CODLING MOTH

By C. P. GILLETTE, *Fort Collins, Col.*

When Doctor Headden announced[1] his conviction that the arsenical sprays used for the control of the codling moth are, in many instances, killing the apple trees, he was asked to suggest some poison that would be less injurious to the trees and still give promise of killing the worms. He suggested trying sulfid of arsenic ($As_2\ S_3$), and expressed the fear that it would not be sufficiently soluble in the digestive fluids of the larvæ to kill them. Knowing something of the great digestive powers of insects, I expressed to the doctor a very strong desire to try arsenious sulfid in comparison with arsenate of lead in some codling moth spraying experiments already planned for 1909. Doctor Headden first prepared a small quantity in liquid form which was tested upon different kinds of foliage in the insectary to determine the strengths that might be safely used upon the leaves.

It was nearly time to begin the work of spraying for the codling moth, and as we could not obtain a sufficient quantity of this poison near at hand for the experiment, Doctor Headden converted his experimental laboratory into a laboratory for the manufacture of arsenious sulfid.[2] Enough was made to use upon a few trees and was sent to

[1] Bulletin 131, Colo. Agr'l Exp. Sta.

[2] Doctor Headden describes his preparation of the poison as follows: The arsenious sulfid was prepared by the usual method, *i. e.*, precipitation by hydrogen sulfid. The washed precipitate was dissolved in lime-sulfur solution, usual strength. The lime-sulfur solution was used because it dissolves, or is assumed to dissolve, the arsenious sulfid to a sulf. arsenite without the formation of an oxygen salt, the arsenite which I wished to avoid, as

Mr. George P. Weldon, field entomologist of the Experiment Station, located at Delta, with instructions to use it in comparison with arsenate of lead. The arsenate of lead was being tested at 2, 3 and 4 pounds to each 100 gallons of water in one application only when the petals were about nine-tenths off.

The arsenious sulfid was used in two strengths to correspond with the two stronger preparations of arsenate of lead in amount of metallic arsenic contained.

The applications were made by Mr. Weldon with a hand pump with moderate force, but the treatment was thorough and in every way was made as nearly like the lead arsenate sprays as possible.

The results of the experiment as tabulated by Mr. Weldon are here given:

The trees sprayed with 2 pounds of arsenate of lead to 100 gallons of water averaged 94.7 per cent of their fruit free from all worm injuries. The trees that were sprayed with 3 pounds to 100 gallons bore fruit that was 95.5 per cent free from worm marks. Trees sprayed with 4 pounds to 100 gallons bore fruit that gave exactly the same percentage of worm marks as when 3 pounds were used.

The trees sprayed with sulfid of arsenic had 93.6 per cent perfect fruit upon trees sprayed with the weaker preparation, and 92.7 perfect from the trees where the stronger solution was used.

The check trees average 58.9 per cent sound, or perfect, fruit, so far as worm injuries were concerned.

All of the experimental blocks, both sprayed and checks, were in a large orchard, all of which was sprayed. Check trees in such a case benefit greatly by the spraying of surrounding trees and do not show the contrast that they should with the results upon sprayed trees. Two orchards in the same vicinity, one very poorly sprayed and one not sprayed at all, bore apples that were 70 to 85 per cent wormy.

So this test of sulfide of arsenic as a spray for the control of the codling moth indicates that this poison may be as efficient for this

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I am convinced that a pure preparation of lime arsenite is not good to use.

The solution probably contains the whole of the arsenic in combination with sulfur. The lime-sulfur compound is easily decomposed by the carbonic acid of the air, while the arsenious sulfid withstands the action of water, air and carbonic acid very effectively. The sulfid of arsenics $As_2\ S_3$ contains essentially 61 per cent of its weight of metallic arsenic, while lead arsenate contains less than 10 per cent (9.87).

The chief thing, however, is not that it may be placed on the market at a lower price, but that it will remain longer in the soil in an insoluble form than the compounds heretofore used. It is only a mitigation of the evil, however, not a complete avoidance of it.—W. P. Headden.

purpose as the arsenate of lead, which has, in the past few years, almost completely taken the place of other poisons for the control of the codling moth and other leaf-eating insects.

Three other sprays, viz., lime, Black Leaf Extract, and Sulfate of Nicotine, were also tested in hopes that they might prove beneficial. As with the arsenical sprays, each was used but once, as the petals were nearly all off.

Good lump lime, 50 pounds to 100 gallons of water, seemed to give no protection at all, as the percentage of perfect fruit on these trees averaged 58.9, exactly as in case of the check trees.

Black Leaf Extract was used in the proportion of 1 gallon diluted to 50 gallons with water. The trees sprayed with this mixture gave fruit that was 77 per cent free from worm injuries, or about 18 per cent more perfect fruit than in the check block.

Sulfate of Nicotine was used in the porportion of 1 part in 750 parts of water and seemed to give slight protection, as the trees sprayed with this mixture bore fruit that was 73 per cent free from all worm injuries, an improvement of practically 14 per cent over the fruit of unsprayed trees. Even this application indicates a protection of almost exactly 33 per cent of the fruit that would have been wormy if untreated, for the check trees had but 41.1 per cent of their fruit injured by worms.

While I would not feel warranted from this year's experiments in holding out very strong hopes that the codling moth can be sufficiently controlled by the use of nicotine sprays, I am encouraged to continue the experiment through another year and shall probably extend the number of applications to three or four. One or two summer sprays with either of these tobacco preparations will usually pay for themselves in their destruction of plant lice, red spiders and brown mites. And then, if these nicotine sprays will enable us to get fairly good protection from the injuries of the codling moth, it will be a boon to those whose orchards are already sick and dying from the excessive use of arsenical mixtures.

My chief hope, however, for relief from the overaccumulation of arsenic in our soils in a form that is detrimental to the growth of vegetation, lies in the use of the very insoluble sulfide of arsenic. This compound also has the important advantage of being very much cheaper than arsenate of lead, and if we can use it in solution it will do away with the use of stirrers in the spray tanks, which will be another decided advantage.

I have also used this poison successfully, as an arsenic-bran mash, for the destruction of grasshoppers, and as a spray for the destruction

of cherry slugs, and the larvæ of the white ermine moth, *Diacrisia virginica* Fab., but I did not compare the results in these cases with the effects of other arsenical poisons in parallel tests.

MR. J. B. SMITH: Will Professor Gillette please tell us how this poison is prepared and where it can be secured?

MR. GILLETTE: The poison was prepared for me by Doctor Headden and the method of making it is explained in the footnote given in the paper. I do not think it can be secured at present, unless it is made up specially for the purpose.

MR. FORBES: I realize that it is getting late, yet I think if the subject of arsenical poisoning on fruit trees is not taken up we will lose a great deal of information which should be of great value to the members of this Association.

Doctor Headden has been working on this matter in Colorado, and while some of his results may refer directly to Colorado conditions, I think the whole matter should be of great interest to our members, especially as some of us have conditions to deal with which are in a way similar to those in his state. I trust we shall have time to hear from Doctor Headden concerning this matter.

PRESIDENT BRITTON: We will be glad to hear from Doctor Headden.

ARSENICAL POISONING OF FRUIT TREES

By W. P. HEADDEN, *Fort Collins, Col.*

[Summary of remarks]

There are some facts in regard to which all agree, namely, that we have many sick fruit trees; particularly apple and pear trees. I do not for a moment wish to assert that all of these sick trees are suffering from arsenical poisoning, nor that all of the dead ones have been killed by arsenic. But I do believe that many of them have died from this cause. Other causes which might have produced death are winter killing, accumulation of nitrates in the soil, fungi of different kinds, possibly blight and still other causes.

The trees referred to have not been killed by freezing. We have very little of this in the state, and these cases present no similarity to those attributed to arsenical poisoning. The former in this latitude produces its injury above the surface of the ground, and the injury is really effected beneath the bark. Arsenic begins its attack below the surface of the ground and on the outside of the bark, converting

it into a black friable mass, which may be found of all thicknesses, from thin layers forming scarcely more than a discoloration to masses involving the whole thickness of the bark and the woody tissue underlying it. We find many trees showing this progressive destruction of the bark and tissues. The same statement holds good for the roots, which are attacked with the crown of the tree. Sun scald, a form of winter injury, is an entirely different thing, both in location and appearance; while the bark may be killed in spots, its structure is not destroyed. It is not a blight of any form; a large number of inoculation experiments have been made which have uniformly failed.

It is not due to the attacks of fungi; these have never been found in these trees in such association with the disease as to even suggest a causal relation. It is not due to drowning or excessive water, for we find cases of badly corroded crowns in localities where the water plane is many feet below the surface, and a permanent excess of water kills and rots the feeding roots. It is not due to alkali; whatever we may understand by this term, we have in some districts what is popularly designated "black alkali." This is not the "black alkali" of California; we have so far as I know absolutely no alkali in Colorado, consisting largely of sodic carbonate.

There is one occurrence of sodic carbonate in the state, which I described in the *American Journal of Science* April, 1909. That this so-called black alkali is dangerous and kills trees is true. The active agent in this case is some nitrate, calcic, magnesic or sodic. The crowns of trees killed by this are invariably healthy unless involved by the presence of arsenical poisoning, as may be the case in orchards that have been sprayed. I have seen many trees killed outright in a few days by these nitrates. The two cases, *i. e.*, death due to arsenical poisoning and death due to nitre poisoning, are *in toto* different.

I have seen one case in which the arsenic had lodged in the crotch of a tree and produced the same results as about the crown. This case was easily distinguished from the effect of snow, etc., lodged in similar places.

All that has been said so far pertains to the corrosive action of arsenic, but it may be justly asked how may we know that arsenic produces the effects described? Our answer is we have observed the destruction of the bark, the disintegration of the woody tissue and the killing of trees by arsenic.

So far I have referred to the corrosive action of arsenic when it accumulates in the soil about the crown of the tree. There is another phase of the question which I believe we find in some orchards much more pronouncedly than the one already presented, and this is the

question of absorption of arsenic by the roots with the nutrient solutions. We have some cases of trees decidedly small for their age; the bark has an unhealthy color, the foliage is small. The trees make very little growth and yield fruit of medium size but of very high color. We find some trees in these orchards with corroded crowns, but the trees to which I now allude are not affected in this way. Some of these trees have died, the heart wood was found to be stained, the bark was yellow and cracked and the woody tissue was rich in arsenic. The general condition of the orchards is one indicating malnutrition. Neither a lack nor an excess of water can be appealed to as factors in these cases, for the land is in all cases that I have in mind high and the supply of irrigation water abundant. There is, further, no deficiency of plant food in the soil, provided the results of a chemical analysis have any value whatsoever. All of the orchards in which I have found these conditions obtaining are well cared for, and the condition cannot be attributed to neglect. These trees often show bleeding from wounds made in trimming, also from longitudinal cracks in the bark. The material which collects on these wounds or flows from the cracks in the bark is rich in lime, 25 per cent calcium oxid, and also in arsenic. I cut off a limb in April and gathered 2.2 grams of the dried juice from the surface of the wound in early May and found it quite rich in arsenic. It seems evident that this arsenic must have been gathered from the soil by the roots, at least the arsenic was at that time in motion through the tree. I have further proof that the roots gather arsenic from the soil. The wood of peach trees not themselves sprayed, but growing in ground that contains arsenic, has been found to be quite rich in arsenic; leaves gathered from trees that had not been sprayed this season, but heavily sprayed during preceding seasons, contain arsenic, and fruit grown on such trees contain arsenic. In these cases there is no question of absorption of arsenic by simple contact with the spray material. It is in the solutions which diffuse through the tree and nourish all of its parts. This seems to me to reduce the question of systematic poisoning to the one question of how much arsenic a tree can tolerate. The small size of the trees and their general condition of malnutrition corresponds to the observed effects of arsenic in cases in which we know it to have been applied and produced the injury.

There is still another question, one which I have referred to whenever considering this subject, *i. e.*, what may be the significance of the lime in these dried juices? These orchard soils, in fact nearly all of our soils, are limey; much of our land is underlaid by marl; it is, however, also true that much arsenite of lime has been used for

spraying. Now nearly all, if not all, of these marls contain arsenic, but in small quantities compared with the surface soils. These things, apparently, all work together to produce the effects described, but neither the marl nor the arsenic in the marly soils can be blamed for the arsenic in the trees and the fruit, for this is a very widespread condition. I have examined fruit from the following states: California, Colorado, Michigan, New York, Illinois, Ohio and Pennsylvania and uniformly found arsenic. No one, however, need to be alarmed about the amount of arsenic present being in the least dangerous, for they would scarcely obtain an ordinary medicinal dose if they ate ten pounds of apples a day. Arsenic, however, can be detected in the urine of parties eating very freely of such apples. I will, however, reserve this subject for discussion elsewhere.

Mr. Headden exhibited samples of roots which had been injured by arsenical poisoning, as well as small tubes showing the results of analysis of fruit trees from various sections of the country, and one of these tubes contained a mirror which had resulted from the analysis of an elm tree that contained a considerable amount of arsenic.

Member: I would like to ask whether Doctor Headden has noticed any connection between the appearance of arsenical poisoning and the amount of moisture. Is it more likely to appear in a tree standing in dry or wet soil?

Mr. Headden: Colorado orchards are irrigated, and it is possible that the arsenic is carried down to the roots sooner with us than where the soil is not treated in this way. Nevertheless, analyses have shown that sick trees on almost all kinds of soil showed the presence of arsenic in considerable quantities, if they had been sprayed.

Mr. Washburn: I would like to inquire how Doctor Headden secures his samples, in order to determine whether the tree is suffering from arsenical poisoning, and how large a piece of bark would be necessary to detect the poison.

Mr. Headden: I have always endeavored, in taking the samples, to refrain from selecting any of the outer bark of the tree, as this is liable to be covered to some extent with poison, especially trees that have been recently sprayed.

The wood just below the bark is usually selected for this purpose, but in cases of root injury the woody tissue of the roots is used, but not the bark.

Mr. Washburn: Is not this fact more striking in alkali soil? I

would also like to ask how much of the wood it is necessary to use as a sample in making an analysis?

MR. HEADDEN: In some cases I have found that a piece of wood an inch or two long and an inch wide would be sufficient to show the presence of arsenic. Generally I use about two ounces.

In a soil normally alkali and dry, some trees that have been sprayed from one to four times have shown effects of arsenical poisoning.

MR. SANDERSON: Does poisoning result from the insecticide coming in contact with the trunk of the tree, or are the roots alone affected?

MR. HEADDEN: I do not know how much, if any, poison may be absorbed by the contact, but where it collects about the crown it corrodes both the trunk and the roots.

MR. SANDERSON: Is there any more poison in the roots of the tree than in the trunk?

MR. HEADDEN: I do not know. I have separated the small branches and analyzed them and found abundant evidence of arsenic.

MR. FELT: How soon, after spraying, does a tree die?

MR. HEADDEN: I have known a young tree to die after three sprayings. Professor Gillette and I examined an old orchard, and not one of the old trees showed any effects of poisoning, but every young tree gave signs of the trouble. The age of the tree when first sprayed may make some difference.

PRESIDENT BRITTON: As Prof. F. William Rane, of Boston, is now present, we will listen to his paper on the present condition of the "Gypsy and Brown-Tail Moth Work in Massachusetts."

PRESENT CONDITIONS OF THE GYPSY AND BROWN-TAIL MOTH WORK IN MASSACHUSETTS

By F. W. RANE, *Massachusetts State Forester*

The work against the gypsy and brown-tail moths was placed under the State Forester by an act of the last General Court. Many changes in organization and previous policies have been made. The infested territory has been divided into fifteen divisions instead of six as heretofore, and the force of experts now responsible to the main office is nineteen as compared with fifty. The superintendents of divisions have been provided with motor cycles, and the State Forester feels confident that the organization is capable of doing more effective work than ever. The work of spraying has increased in usefulness and thereby much of the more expensive hand suppression work like turning of burlaps has diminished. The Department of State Forester has established a supply store, which is proving a great saving of

money in the purchasing of supplies. The organization of local workers so as to accomplish more effective results is being undertaken at the present time.

The number of acres sprayed throughout the infested district during the season was 7,776, the number of burlaps put on 698,597, and number of tanglefoot bands 26,313. We have 150 power sprayers and 250 hand outfits employed in the work.

These figures are of course approximate.

Parasites. The introduction of parasites into the field has been carried on more effectively than ever before. The United States Government entomologists assure us of more hopeful indications than ever from their work.

The State Forester is having prepared a special report on the parasitic insects that will, it is believed, prove of great interest to our people.

The fungous disease and wilt disease of the moths are also receiving attention by noted experts, and it is hoped beneficial results will be forthcoming from these sources.

Prospects for the Coming Year. The prospects for the coming year look very bright. It must be recognized that this work necessarily must take time and patience on the part of our people, but with better equipment and a thoroughly organized corps of men ready and willing to exert themselves when the work must be done will go very far towards balancing conditions until the insects can be brought under control.

Modern Forestry and Insect Warfare. The more the subject of modern forestry is studied the clearer is it shown that if forestry practice was carried on as it should be for economic results, the great expense incurred in fighting insect pests like the gypsy moth would be reduced to a minimum.

The gypsy moths give us the greatest trouble in wild, neglected woodlands and in thickets and tangles found along the highways, or on poorly kept estates.

One thing our people cannot help but recognize is that where modern methods have been practiced through thinning and exercising some sort of management for the good of the trees, here conditions are not as bad as elsewhere. Then, again, under the latter management, should the infestation increase, the conditions are so much more favorable that the expense of warfare against the pest is greatly reduced.

It is really possible that the gypsy moth scourge may cause certain sections to practice modern forestry and thereby in the end gain

financially in getting a better forest product, both in volume and quality, than would have happened had the insects never appeared.

From the experience gained already, we have demonstrated that where we have a clean stand of pine the forest can easily be protected against the gypsy moth. There are few species of forest products worth more than white pine to grow commercially at present here in Massachusetts. What is true of the pine is more or less true with other evergreens, hence in the gypsy moth infested territory it is good forestry to grow these species.

The first thing to be done, therefore, with all woodlands is to practice modern forestry management for the benefit of future products regardless of gypsy moths or other depredations; then let come what may conditions are of the best to overcome them.

There is little to be gained in treating egg clusters and combating moths on dead or ill shaped and weed trees and stumps, as one's efforts ought to be centered on those that have prospective value.

We are recommending, therefore, that everyone begin at once to practice modern forestry management and then the insect warfare will be greatly reduced.

President Britton: We will now listen to a paper by Mr. A. F. Burgess, Washington, D. C.

SOME INSECTICIDE METHODS USED IN COMBATING THE GYPSY MOTH

By A. F Burgess, *Washington, D. C.*

From the time that the gypsy moth first became destructive in Massachusetts and active measures were begun to secure its control and suppression, an effort was made to devise cheap and effective means of attaining that end. The results of a large number of experiments have brought about the adoption of a system of treatment throughout the year, which is very effective in controlling the pest, although the expense involved precludes its use in woodland areas of low valuation. The purpose of this paper is to point out some of the methods which have been found effective, and draw attention to their possible utility in combating other insect pests. It is hoped that this may lead to a discussion of the methods used and that it will be possible for some of them to be tried experimentally in other parts of the country.

Treatment of Egg-Clusters. The egg-clusters of the gypsy moth are laid in masses which are covered with hair from the bodies of the

females. The best method of destroying the eggs is by saturating the masses with crude coal tar creosote. To this material is usually added a small amount, about 5 per cent, of coal tar so as to discolor the treated clusters.

In parks and on city streets, where valuable shade trees have been planted, this method might be employed in treating egg-clusters of the white-marked tussock moth, *Notolophus leucostigma*, as this insect sometimes becomes a great nuisance in such places.

As an illustration of some of the methods that have been employed it might be stated that during the present year many of the shade trees in Washington, D. C., which were badly infested with egg-masses of the insect, are being treated by the workmen employed by the District of Columbia. The egg-masses are being burned off the branches of the trees by using a gasoline torch. If it is desirable to destroy these eggs the creosote method would seem to be preferable. It is a well-known fact that the eggs as well as the pupæ of the insect are sometimes attacked by hymenopterous parasites, and in cases of heavy infestation it might be desirable to collect these masses, place them in suitable outdoor cages for the purpose of rearing of parasites in order that these beneficial insects could be liberated, after which the young caterpillars should be destroyed.

Treatment of Larvae. Most of the members of this association are probably familiar with the burlap method used in the gypsy moth work. Trees are banded with strips of burlap cut about eight inches wide. The burlap is fastened with a string at the center and the top turned down in such a manner as to make an excellent hiding place for caterpillars. A large number of different species of insects frequent these burlaps, and in some sections quantities of such injurious species as the elm-leaf beetle in the larval and pupal stages are often found beneath them. An adaptation of this method might be used in the fall of the year on the base of the trees, for the purpose of furnishing hibernating quarters for injurious insects. I have been informed by Mr. C. W. Prescott of Concord, Mass., that he has been able to capture and destroy large numbers of hibernating asparagus beetles by using this method. It is cheap and in some cases may be used to good advantage.

Banding trunks of trees with tanglefoot, a sticky material which prevents caterpillars from ascending them, is being used more extensively each year in the gypsy moth work, and although a method involving a similar principle has been used for many years, viz.: banding apple and elm trees with tar or printers' ink for the purpose of preventing female canker worms from reaching the small twigs or

branches, it might be well to mention the successful use of the material.

The greatest advance in the perfection of methods for destroying the gypsy moth has been along the line of new spraying devices. Previous to the year 1900 hand pumps mounted on barrels or hogsheads were used for furnishing power. Since that time gasoline engines have been utilized to a greater or less extent, especially in the large fruit-growing districts throughout the United States. This method was tried in the gypsy moth infested territory after the work of suppression was resumed in 1905. A gasoline engine with a suitable pump mounted on wagon trucks with a spray tank having a capacity of 300–500 gallons has been employed. The Vermorel or Bordeaux nozzles and lines of ½-inch hose were used, and it was necessary to climb tall trees in order to treat them thoroughly. It was not possible to cover very many large trees in a day when an equipment of this sort was used.

As early as 1895 a steam spraying outfit was devised and used in Prospect Park, Brooklyn, New York, by Mr. J. A. Pettigrew for treating trees for the elm-leaf beetle. With this outfit high pressure was developed, so that the trees were sprayed from the ground. A description of the sprayer was published by Dr. L. O. Howard in an article entitled "The Use of Steam Apparatus for Spraying," in the Yearbook of the United States Department of Agriculture for 1896.

After Mr. Pettigrew was made Superintendent of Parks of the City of Boston he continued to use a similar outfit for treating elm trees infested with this insect.

In the spring of 1905 the "solid stream" method of spraying was tested by General S. C. Lawrence of Medford, Mass., the trees treated being badly infested with the gypsy moth. The outfit used was built by the firm of Stephen B. Church of Boston, the power being supplied by a high power gasoline engine. The experiment was entirely satisfactory, and since that time this system of spraying has come into general use on the gypsy moth work. Mr. George H. Kermeen, one of the representatives of this firm, was an early advocate of the method and through his efforts many people were interested in its use.

It should be stated that the successful application of the solid stream spray requires a high power engine, a strong pump equipped with a suitable air chamber and a nozzle constructed in such a manner that the stream will be carried to the top of high trees before it breaks into a mist. For park and woodland work, where trees from 50 to 75 feet in height are to be treated, the best outfits now in use are provided with a ten horse power gasoline engine of the marine motor or auto type and a triplex pump capable of discharging at least 35 gallons a

minute. One and one-half inch hose is used, and nozzles similar to those supplied with fire hose are fitted with adjustable tips of 1/8, 3-16 and 1/4-inch aperture. A U-shaped tank of from 400 to 600 gallons' capacity is mounted on the front of a set of wagon trucks and the machinery on the back part.

Since this method of spraying was adopted many improvements have been made by manufacturers. This has been due largely to suggestions made by the officials engaged in the spraying work and has resulted in a great increase in the efficiency of the machines.

In field work it is usually desirable to use a one-fourth-inch nozzle tip and to maintain a pressure above 200 pounds.

With an outfit of this sort about 12 acres of woodland can be treated each day at a cost averaging $10 per acre. When forests are sprayed it is necessary to lay long lines of hose from the machine, which whenever practical is located near a supply of water. Effective work has been done when the spray mixture had to be forced through a hose over a quarter of a mile in length.

Mr. D. M. Rogers, Special Field Agent of the Bureau of Entomology, who has charge of the gypsy moth field work in New England has devised an apparatus known as a "water tower," which is mounted on the top of the spray tank and is used for treating roadsides. It consists of a steel tube about 20 feet long, which is attached to a mast six feet high. The bearing on the mast, which is about four feet from the end of the tube, is fitted with a universal joint, so that the nozzle, which is attached to the outer end of the tube, can be moved in any direcion desired by the operator. The short end of the tube is reinforced with a quantity of lead so that the tube nearly balances on the mast. The supply hose is attached to this end, and by using this device it is possible to spray two miles of roadway in a single day at a cost of less than $2 an acre.

During the past few months a new sprayer has been devised and built by Messrs. L. H. Worthley and Melvin A. Guptill of the Massachusetts State Forester's office, which has given very satisfactory results. Special care was taken to overcome the objectionable features of the machines previously built, and it was possible to do this and at the same time decrease the weight of the outfit and add to its efficiency. A new type of nozzle has also been devised by these gentlemen and a coupling which does not reduce the diameter of the hose at the point of connection. These devices will be exhibited and demonstrated before the close of the meeting.

The spraying outfit used on the gypsy-moth work should be of spe-

cial value for treating trees in parks and cities, and in most cases they can be used for such work without any special modification.

For orchard spraying or treating low-growing trees, the same system could be used, but it would be necessary to reduce the weight of the outfit and make changes that would render it more suitable for this class of work.

All spraying must be done rapidly and thoroughly if satisfactory results are secured. This system of treatment seems to answer these requirements, and if modified sufficiently to conform to the special kind of work desired it should give satisfactory results.

MR. HEADLEE: Has the dust sprayer been used in Massachusetts on the gypsy moth work? I noticed in the exhibition room an apparatus for spraying trees, using dry arsenate of lead, and would like to know what success has been attained with this method of spraying.

SECRETARY BURGESS: So far as I know, the dust method of spraying has not been used on the gypsy moth work. Last season some experiments were conducted with a bomb made somewhat similar to the bomb shells used for fireworks. This shell carried a charge of dry arsenate of lead, which was shot up into the air and exploded, so as to distribute the poison over the trees below. Its only use is in inaccessible woodland areas, where it is impossible to use a wet spray. This device is only partially successful; one of the troubles being that it was not possible to secure a grade of dry arsenate of lead which was fine enough to be distributed evenly over the trees.

MR. FROST: The gypsy moth problem in New England is a most extensive one, and owing to the large areas of woodland which are infested, I believe at the present time is more of a forestry problem than an entomological problem. The forest area which is infested is largely covered with deciduous trees, which suffer greatly from the attacks of the insect. Last winter the gypsy moth work was placed in the hands of the state forester, and I am inclined to think the problem can be worked out better along forestry lines.

While in Europe during the past summer, I was surprised to note the large number of coniferous trees which exist, as compared with the relatively small areas covered with deciduous growth.

It seems to me that this may be one factor in holding the gypsy moth within bounds in that country, as the young caterpillars cannot feed upon coniferous trees.

I am inclined to think it will be necessary to reforest large areas in the gypsy moth infested district, by replacing the hardwoods with

pine. By following up this method, it will be possible to control to some extent the damage caused by this insect.

MR. HEADLEE: Do I understand that a new coupling has been devised for use on the gypsy moth work? We have had considerable trouble with the couplings which we have used on hose in our spraying work, and I would be glad to hear more about this plan.

MR. RANE: Mr. Worthley and Mr. Guptill have devised a new style of coupling which has proven of great value in the gypsy moth work. I hope Mr. Worthley will explain the coupling fully.

MR. WORTHLEY: One of the troubles which we have always had in our spraying work has been that the diameter of the hose at the coupling was considerably reduced, when we used those now on the market. This being the case, it has been necessary to use 1½-inch hose in order to carry a sufficient amount of liquid.

The new coupling which has just been devised is of the same size as the inside of the hose, so that the stream is not choked when passing through the coupling.

This will enable us to use 1-inch hose, and will reduce the expense of equipment and the labor involved in laying lines of hose for spraying operations.

MR. SHERMAN: The last few papers on the program have detailed two radically different methods of spraying, and the remarks made by Doctor Headden seem to indicate that we should depend on some other method than heavy arsenical treatment in order to control leaf-eating insects. These matters are of great interest to the entomologist and should be more thoroughly investigated.

MR. FROST: I would like to make some remarks in regard to the injury to trees as a result of spraying with arsenical poisons.

Since 1896 we have repeatedly treated many trees, of all kinds, with arsenate of lead, and in this work have used about one pound to ten gallons of water. In spite of this fact, I have failed to see any trees which showed signs of injury from the poison.

Many people are prejudiced against spraying if they are led to believe that the trees will be injured, and this has caused considerable trouble and annoyance in the past.

It seems as though, if the trees were going to be injured by arsenical spraying, many of them would have died from this cause in eastern Massachusetts, but I have been unable to find any indications of this trouble.

MR. WORTHLEY: I would like to ask Doctor Headden if forest and shade trees are injured by arsenical poisons in the same way as orchard trees.

Mr. Headden: The only record I have along this line is the case of an elm tree which had been sprayed. Analysis showed a large amount of arsenic in samples taken from this tree.

Mr. Gillette: It is probable that orchards will ordinarily suffer more than forests, for the reason that most of them are cultivated, which serves to work the poison into the ground and bring it in contact with the roots more rapidly than would be the case in forest areas. If the orchard is irrigated, this would also tend to convey the poison to the roots more readily than if artificial watering was done.

President Britton: While we are discussing the gypsy moth, I think it will be well to hear from the officials in various New England states who are engaged in the work of suppressing this insect, and I will now call on Professor Hitchings from Maine.

Mr. Hitchings: Our work in Maine has followed along the same lines as that in Massachusetts. We, in Maine, have felt that we could not improve on the system adopted in Massachusetts, where the insect has been fought for many years, as our conditions are quite similar, and therefore we have been carrying on the work in the same way.

In Maine, the field work is in charge of a special agent appointed by the Commission of Agriculture, who has charge of the men. The force is divided into sections, and we feel that very effective work has been done in controlling the insect and keeping the infested section in good condition.

The situation at the present time is a serious one, and it is necessary for every effort possible to be put forth, in order to hold our own in the conflict. Our investigations lead us to believe that in some localities the young larvæ of the gypsy moth must have been carried by birds or four-footed animals. The locations of some of the colonies in the woodlands gives strong evidence that this is the case.

President Britton: I notice that Captain Philbrook is in the audience, and as he is the special agent, having charge of the field work in Maine, I know you will all be glad to hear from him.

Mr. Philbrook: I don't know as there is anything to add to that which has already been said.

I might mention one point which has not been touched upon—in regard to the spreading of the moth—and that is that invariably in woodland colonies we find that at some time previous a portable sawmill has been temporarily located in the vicinity. In some cases these sawmills have been shipped from localities badly infested with the gypsy moth, and this evidence shows that the insect can be distributed in this way.

So far as Maine is concerned, the conditions in the towns are very good.

We find this year that there are several large colónies in the deep woodland which had not previously been discovered.

President Britton: We would now like to hear from Col. Thomas H. Dearborn, who has charge of the gypsy moth work in New Hampshire.

Mr. Dearborn: I have been much interested in the gypsy moth discussion which I have listened to this afternoon. We have in New Hampshire a large infested area, although the greater part of it was not known to be infested until within the last two years. Within a week, a force of gypsy moth men have found in a woodland near Durham, N. H., a very bad infestation, and this leads me to believe that the insect has been established in woodland areas in the state much longer than we have suspected.

Numerous other colonies strengthen this opinion, and I am inclined to think that if the woodland area of the state could be examined many large colonies would be found which have been present for a good many years.

President Britton: I do not see Professor Stene in the audience. Is there anyone who can report from Rhode Island?

Mr. Polke: I am not in charge of the moth work in Rhode Island, but have worked with Professor Stene and am thoroughly acquainted with the conditions there.

We have copied Massachusetts as regards the methods which are used for fighting the gypsy moth, and I fear we are going to copy Massachusetts too far, in that there is serious talk of withholding our appropriation at the coming session of the Legislature.

The condition of the infested territory in Rhode Island is improving each year, and if we are able to bring sufficient pressure to bear on the Legislature, so that the appropriation for the work will be continued, the moth infested area can be greatly reduced next year.

Mr. Sanderson: I have always felt that we did not have sufficient information concerning the methods of the spread of the gypsy moth. We know that the brown-tail moth has spread in a northerly direction, and this has been presumably due to the fact that the prevailing wind is in this direction during the period when the heaviest flight of the moths takes place. The spread of the gypsy moth has been in a northerly direction, and it seems to me that this matter is of sufficient importance to the whole country so that it should be thoroly investigated. It is quite possible that the young larvæ-bearing ærostatic hairs may be carried by the wind.

President Britton: We will now call on Mr. Rogers, who has charge of the gypsy moth field work in the United States Department of Agriculture.

Mr. Rogers: Since Mr. Headlee spoke about the bomb, I would like to say a few words in regard to it. We have large tracts of woodland which are inaccessible to spraying machines carrying water.

Mr. Fiske asked me to show this device in the exhibition room for distributing dry arsenate of lead over the trees while they are wet with dew, or after a shower. We have met with no marked success in its use, and it is shown only as a novelty, hoping that it might interest some of you.

The government moth work is conducted in coöperation with the officials of the different infested states. We have now over four hundred men at work in the field, clearing roadsides of underbrush, destroying the eggs of the gypsy moth, and cutting clusters of the brown-tails.

We have about one hundred men doing scouting work and about thirty in Maine, with a crew of twenty or more in Rhode Island.

I would like to mention a device which we have used with considerable success in spraying, which we have termed a water-tower. It is a long piece of steel tubing hung by a universal joint from the top of a short mast; the hose from the pump being attached to the lower end. The operator stands on the top of the tank and uses the part of the tube below the mast as a handle for swinging the nozzle about over the trees. The nozzle is about twenty-five feet above the ground, so that we can cover the top of trees one hundred feet high without climbing.

Mr. Worthley of the state office is making some experiments with a new nozzle, which I think, if explained, would benefit all of us.

President Britton: We would like to hear from Mr. Worthley before closing this discussion on the gypsy moth work.

Mr. Worthley: Mr. President, I think this subject has been very fully covered this afternoon, but I would like to mention the fact that the state of Massachusetts is exerting itself to the utmost in its warfare against the gypsy moth. We have carried on the campaign over a large area of country, and the residential sections which were infested are now in a very good condition. The woodland problem is the most difficult one to handle. The work is being pushed as vigorously as possible.

Mention has been made of the new nozzle which has been devised for the spraying of trees. This will be exhibited before the meeting closes, and a demonstration of its work will be made. By using this

device, it is possible for sufficient pressure to be maintained to spray trees seventy to eighty feet high without climbing them.

I trust as many of the members as possible will examine these spraying devices, which are being used in this section, and we should certainly be glad to receive any suggestions looking toward their further improvement.

PRESIDENT BRITTON: The next paper will be presented by Prof. H. A. Surface, Harrisburg, Pa.

SOME NEW FACTS IN REGARD TO LIME-SULFUR SOLUTION

By H. A. SURFACE, *Harrisburg, Pa.*

[Withdrawn for publication elsewhere.]

PRESIDENT BRITTON: We will now hear Mr. F. B. Lowe, Detroit, Mich., who will present a paper entitled "Studies in Insecticides."

STUDIES IN INSECTICIDES

By F. B. LOWE, *Detroit, Mich.*

[Paper not received in time for incorporation in the proceedings.—ED.]

PRESIDENT BRITTON: The next paper on the program will be by Mr. W. E. Hinds, Auburn, Ala.

CARBON DI-SULFID FUMIGATON FOR THE RICE WEEVIL IN CORN

By W. E. HINDS AND W. F. TURNER

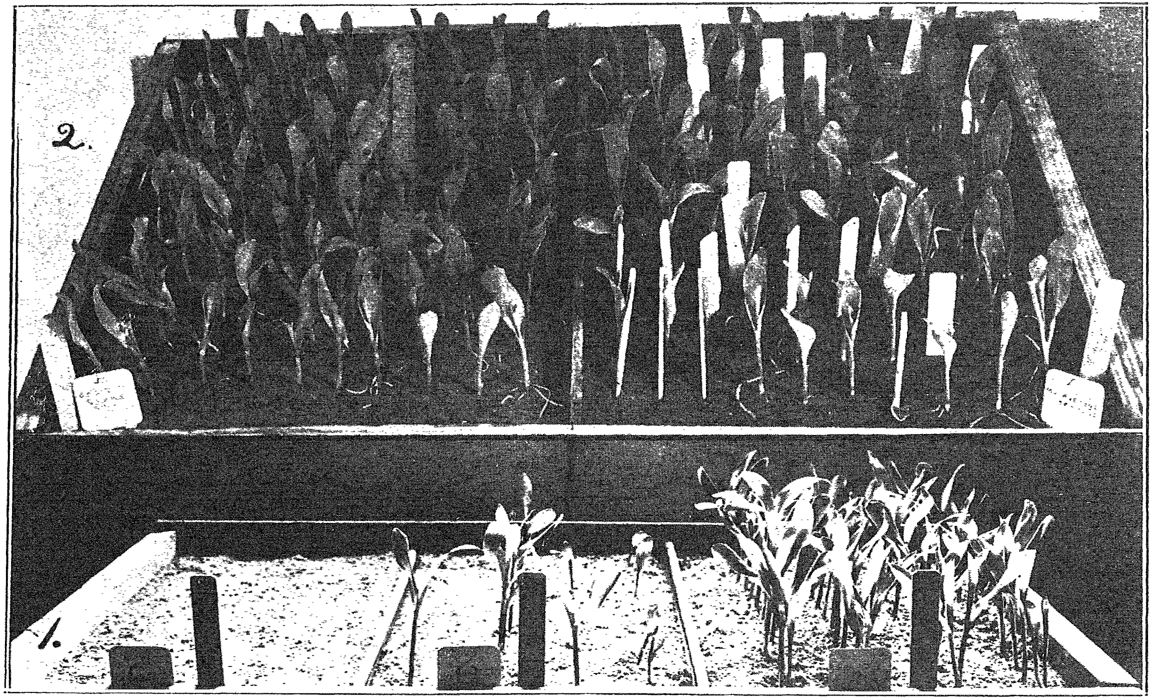
At the meeting of the Association of Economic Entomologists held in Baltimore one year ago, announcement was made of a project for the investigation of the use of carbon di-sulfid as a fumigant. An outline of this project was given, and also, in a separate paper entitled "Carbon Di-Sulfid Fumigation for Grain Infesting Insects," a brief statement was made as to results obtained up to that time. The work of this investigation has been continued during the past year with a gradual increase in the scale of the experimental work as the results obtained have seemed to demand and warrant.

In addition to the project upon fumigation, another project for the investigation of the life history, economic relationships and injury of the rice weevil (*Calandra oryza* L.) has been approved for the Alabama station. The imperative need for work along the lines contemplated in each of these projects has been frequently emphasized dur-

ing the past year by a large number of inquiries as to methods of exterminating insects in stored grain. There is no question but that the rice weevil is at present the most seriously injurious species of insect occurring in Alabama, and agricultural conditions at the present time indicate that the importance of its control will be greatly increased in the near future. During the past one or two years, there has been a general movement through the Southern States to increase the cultivation of corn. One of the most potent factors in this campaign has been the continued spread of the Mexican cotton boll weevil. The demonstration farm agents, under the direction of Dr. S. A. Knapp, have largely extended their work. State departments of agriculture have conducted campaigns through the offering of large cash prizes for the best yields of corn per acre, and many corn clubs, as they are called, have been formed. As a result of these and other educational influences, there has been during the past year more attention given to corn culture in the Southern Gulf States than was ever previously given to that subject. Crops of from 100 to 150 bushels per acre have been raised in many cases. Boys, who have entered the competition in the corn clubs have, as a rule, secured better yields than did their fathers; the demonstration farms generally yield crops of from two to three times the average in their localities. But possibly one of the most potent factors in the new effort to raise more corn has been the high price which corn has commanded during the past year. Planters who have raised only cotton, and depended upon buying what corn they might need, have been obliged to pay from 75 cents to $1.25 per bushel for corn. A large proportion of this corn has been shipped into Alabama from other states. Planters have come to realize that they cannot profitably produce cotton alone and buy corn at $1.00 or more per bushel with which to feed their working stock, nor can they afford to raise hogs and feed them upon corn, for which they must pay such prices, and they have become convinced also that the South is capable of producing practically as large corn yields as those obtained in what are known as the corn producing states.

During 1908 the corn yield of Alabama was estimated by the best authorities at approximately forty-four million bushels, having a cash value of about $37,000,000, or about 84 cents per bushel. The yield for 1909 will, in all probability, prove to have been even greater than that of 1908 and of higher average market value.

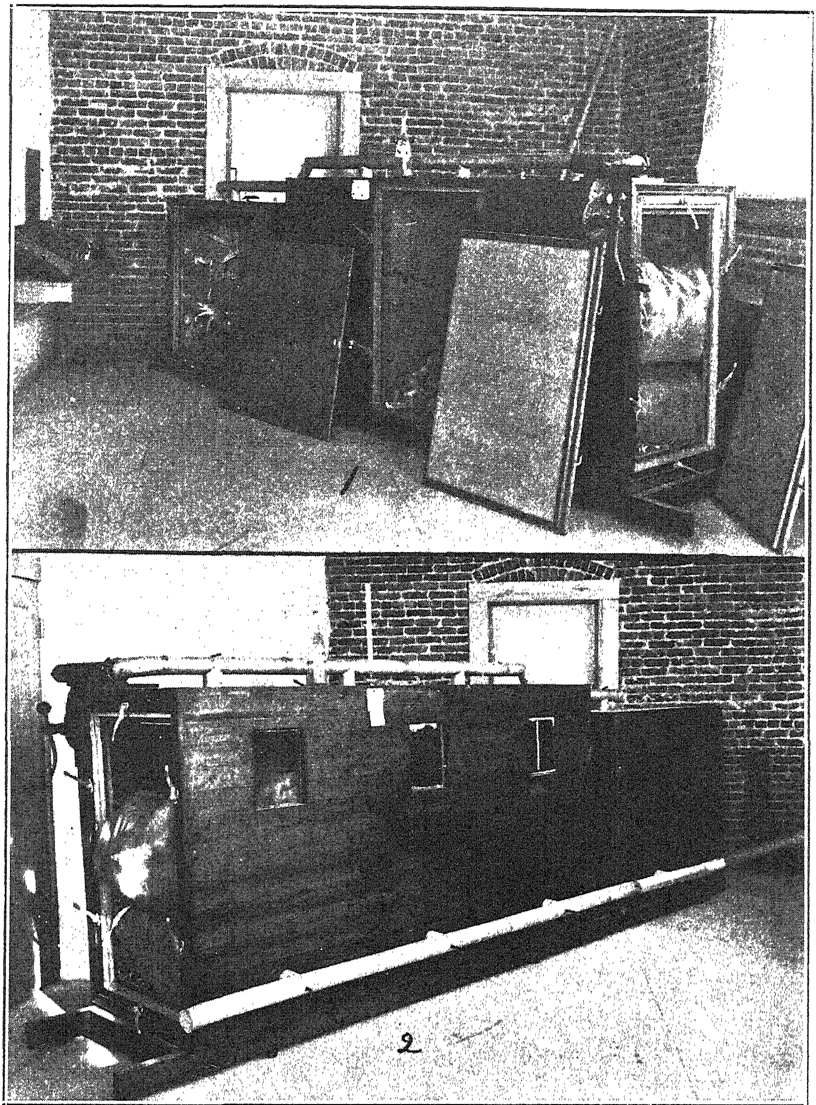
The large percentage of injury to corn held through the winter has been one of the factors in keeping many planters from raising more corn. While the injury is liable to vary from year to year, it is fre-



RICE WEEVIL INJURY TO CORN GERMINATION

Fig. 1, A. Evidently sound corn: Germination perfect, growth normal. B. Evidently slightly infested kernels but germ apparently sound: Germination 20%, only 10% of normal growth. C. Kernels showing weevil emergence holes, germs evidently affected: No germination.

Fig. 2, A. Kernels as they ran on ear showing but little weevil injury: Germination 80%, only 65% of normal growth. B. Evidently sound kernels from same ear: Germination 100%, growth normal. (Original.)



FUMIGATION BOXES

Fig. 1. Three sections open and doors removed after gas had been driven out. Inlet line of ventilation pipe along top.

Fig. 2. Rear view of boxes. Outlet ventilating pipes at bottom leading out of window. Windows in box for watching temperature fluctuations, insect behaviour, etc. (Original.)

quently sufficient to destroy a large percentage of the feeding value of the corn before the middle of the winter. In some localities, particularly where the land is overflowed during the winter, it appears that the corn is but little affected, while upon uplands especially, ears sometimes contain a hundred or more adult weevils before the first of November. Badly infested corn is almost worthless, since it is not attractive even to hogs. Horses and mules frequently refuse it entirely.

Besides their effect upon the feeding value, the weevils injure very materially the value of the seed for planting. Kernels from which weevils have emerged will rarely germinate at all, and if they start to grow the plant is weak and backward. In the experiments to test this effect, sound kernels were placed in germination boxes in comparison with an equal number which showed but slight traces of weevil injury and also with another lot of kernels from which weevils had emerged. The germination from sound seed was perfect and the growth of the plants vigorous. The slightly injured lot gave 20 per cent germination, but only 10 per cent yielded plants of normal strength. The badly infested lot did not sprout (Pl. 4, fig. 1).

In another series of tests, corn was selected which showed an amount of weevil injury which was considered as a fair average for the condition of corn used for planting at planting time. One hundred kernels taken as the average ran on one side of the middle of an ear, gave 80 per cent germination with about 65 per cent of normal growth. One hundred sound kernels selected from the opposite side of the same ear gave 100 per cent of germination with normal growth (Pl. 4, fig. 2).

The results of these and numerous other germination tests show that weevil injury is in all probability responsible to a considerable extent for irregular stand and lack of uniformly normal growth in the corn fields of the badly infested area. Evidently this is quite an important factor in keeping down the average production of corn to the low yield of about 13 bushels per acre which has hitherto been obtained.

Among the species of insects which injure corn, the boll worm or corn ear worm (*Heliothis obsoleta* Fab.) is the first of importance in the time of its attack. Besides the injury which these worms do directly, it is evident that they prepare the way for increased injury by other species, which later attack the grain. A considerable degree of injury is inflicted by some of the grain moths, both before and after the corn is harvested, but the principal injury after harvesting is attributable to various species of Coleoptera, among which we have found the following particularly abundant: *Calandra oryza, Cathartus gemellatus, Cathartus advena, Silvanus surinamensis, Tribolium fer-*

rugineum and *Tenebrioides mauritanicus*. In the course of observations upon the rice weevil, records are kept relating to each of these other species. It appears that any treatment which insured the destruction of all emerged adults of the rice weevil, was very likely also to destroy the unemerged stages, with the possible exception of the egg, which we have not found in sufficient abundance to enable us to test its resistance satisfactorily. The experiments made thus far indicate that there is a wide working margin between the treatment necessary to destroy infesting insects and that which will endanger the vitality of the infested seed. It is now certain that no single dosage can be safely recommended for all conditions and subjects in this grain fumigation work. The percentage of moisture content in seeds is important as affecting their degree of resistance to the gas. It is also certain that the temperature prevailing at the time treatment is made has a great deal to do with the effectiveness of a given dosage. Thus, a dosage which will kill all stages of the rice weevil at 67 to 70 degrees F. is not likely to kill more than 60 or 70 per cent at 60 to 65 degrees F. The influence of temperature must certainly be considered as two-fold. First, upon the evaporation of the liquid and the diffusion of the gas, and, secondly, upon the condition of activity or inactivity of the treated insects. It appears that with the high temperatures, when the weevils are most active, a far smaller dose of the insecticide is needed to destroy them and the killing time is really much shorter than when the temperature is below 65 degrees. It seems quite probable that this effect of temperature may partly explain the widely varying results which have been reported in the use of carbon di-sulfid.

According to the chemists, the specific gravity of carbon di-sulfid liquid is 1.29, while the vapor is 2.63 times as heavy as air. One volume of the liquid is said to yield 375 volumes of the vapor. Seventy-seven and six-tenths pounds of the liquid is required to saturate 1,000 cubic feet of air at the temperature of 68 degrees, and 84.4 pounds at a temperature of 72 degrees. It is evident, therefore, that in the usual application but a small fraction of the saturated atmosphere has been used.

In our experimental work, we began with small scale tests, using glass bell jars of two litres capacity, in which the proportion of gas could be controlled and its loss by diffusion entirely prevented. A satisfactory method of obtaining any desired dilution of the gas is as follows: Through a stopper in the bell jar or bottle, two tubes may be passed, both of which should be tightly closable from the outside in some way. One tube should reach to the bottom of the jar, while the

other merely passes through the stopper. A similar arrangement is provided for another bottle containing the carbon di-sulfid liquid. On one of the two lines connecting the bell jar and the liquid receptacle, a rubber bulb is inserted, which should be provided with valves so that all air passing through it will be propelled in one direction. By working this bulb a few minutes with the valves open, a saturated atmosphere may be easily obtained at any temperature and the amount of liquid per thousand cubic feet determined if desired. The valves may then be closed and connection made with another bell jar of similar size, and so that in a similar manner the atmosphere charged with bi-sulfid may be divided between the two jars. This gives an atmosphere of one-half saturation, and further division may be made in this manner. Working in this general way, it has been determined that one fourth or one eighth of a saturated atmosphere may be very nearly as quickly effective in destroying weevils as is the full strength, but in either case the question of temperature seems to be equally important. In any case, it is certain that the killing strength of the gas for the rice weevil must be maintained for at least one hour. If further dilution is used, the length of the exposure must be increased to secure death.

In order to test the effect of various strengths of treatment upon a larger scale, we have constructed a fumigation box to facilitate the work. One of these boxes is so arranged that 25, 50 or 75 cubic feet capacity may be utilized. The boxes are so made as to be practically gas-tight, and the doors fitted with double bearings which are thoroughly felted. The doors are entirely removable and fastened in place by six refrigerator bars each. The liquid di-sulfid is introduced through the top of the box by a graduated burette, the dosage quantities being determined in cubic centimeters instead of fractions of an ounce. Arrangement is made for ventilation by a line of three-inch piping connected with a blacksmith's forge fan, and with similar exit pipes through which the gas from any section of the box may be quickly driven out of doors upon the conclusion of the experiment. The openings to these pipes are tightly closed by conical plugs covered with felt. The appearance of the boxes and the method of their use is shown in the accompanying illustrations (Pl. 5, figs. 3, 4). These fumigation boxes have greatly facilitated the application in various tests, but the amount of labor involved in determining the effect, particularly upon immature stages, has been very great.

As indicating the nature of the results obtained in this work, the following table has been prepared:

FUMIGATION IN BOX

Date.	No. of sect.	Temperature.	Lbs. per 1,000 cu. ft.	Duration of exposure.	Effect on insects.							
					Calandra.		Cathartus.		Tribolium.		Tenebrioides.	
					Total stages.	% dead.	Total stages.	% dead.	Total stages.	% dead.	Total stages.	% dead.
Dec. 6....	I	60° F.	20	22 hrs.	246	100%	16	100%	3	100%	8	100%
Dec. 6....	IV	60° F.	20	5 hrs.	265	100%	58	100%	7	100%	3	100%
Dec. 7....	IV	52° F.	15	16¼ hrs.	277	100%	24	100%	19	100%	4	100%
Dec. 13....	III	59°–45° F.	12½	20 hrs.	154	100%	75	100%	3	100%	4	100%
Dec. 13....	IV	59°–45° F.	12½	16 hrs.	151	100%	6	100%	....	....	2	100%
Dec. 13....	II	58°–49°–60° F.	10	24 hrs.	141	100%	72	100%	....	....	5	100%
Dec. 9....	I	45° F.	10	4 hrs.	108	54%	12	16%	....	....	1	0%
Dec. 13....	I	60° F.	7½	24 hrs.	138	100%	87	100%	....	....	....	....
Dec. 9....	IV	47° F.	7½	4 hrs.	213	7%	30	0%	3	0%	....	....
Dec. 16....	II	46° F.	5	20 hrs.	149	95%	37	100%	....	....	....	....
Oct. 28....	IV	....	5	15 hrs.	100% all stages dead.							
Nov. 18....	III	....	4	16 hrs.	570	87%	14	100%	23	74%	21	48%
Nov. 18....	II	....	3	24 hrs.	535	83%	15	60%	2	50%	21	24%
Nov. 18....	I	....	2	85 hrs.	470	79.5%	52	98%	24	100%	14	36%

So far as Calandra was concerned, the results from a treatment at the rate of 3 pounds for 24 hours was the same as with 4 pounds for 16 hours, 83 per cent being killed in each case. In some experiments, 5 pounds was completely effective in 15 hours, while in others only 95 per cent were killed in 20 hours, and the difference seems due entirely to the difference in temperature. Seven and one half pounds at 47 degrees killed 93 per cent in 4 hours and 100 per cent in 24 hours at 60 degrees. Ten pounds was completely effective in 24 hours for all weevils at 60 degrees, as was also 12½ pounds in 20 hours and in 16 hours at the same temperature. Fifteen pounds was completely effective in 16 hours at 52 degrees, as was also 20 pounds in 5 hours at 60 degrees. Further experiments are being made to determine these limits.

Taking up next the work done on a larger scale, we may mention two series of experiments performed at Montgomery, Ala., during the past fall. At one place, some 2,500 to 3,000 bushels of corn were stored in two exceptionally tight buildings constructed for that purpose. The walls and floors of these buildings are of cement and are built solidly to a height of about nine feet above the ground, with the floors slightly lower. Wooden partitions made of flooring divided the buildings into several rooms. The partitions were not at all tight, but the walls up to the eaves were unusually so. Corn was stored in several of these rooms about the first of September. It then contained many weevils, as the infestation during the present season is unusually severe. About two weeks after this corn was stored, the owner applied 20 pounds of commercial bi-sulfid, using about 10 pounds of it in the largest of the cribs, which contained approximately 2,000 cubic feet. The single door was closed, but not so as to fit tightly, and large cracks existed between the roof and the wall at the eaves. This room, therefore, received an application of about 5 pounds per 1,000 cubic feet, and the prevailing air temperature in the vicinity at this time was about 80 degrees (70–91 degrees) for three days. The smaller bins received from 2½ to 3 pounds per 1,000 cubic feet. Examinations of this corn were made about three weeks after the treatment and showed considerable numbers of living weevils, especially near the doors. It appeared that there was still sufficient infestation to warrant further treatment under such unusually tight crib conditions. Even at that time it was evident that the treatment in the larger bin with 5 pounds per 1,000 cubic feet had been quite fairly effective and more so than were the other treatments in the smaller bins.

In preparation for the second treatment, a thorough examination

was made of sample lots of corn taken from near the top, at about the middle and at between one and two feet from the bottom of each bin. Corn in these cribs averaged between seven and eight feet in depth and was all stored with the shuck on. The examination showed that in the large crib an average of about 7 per cent of Calandra survived. In some of the cribs receiving the weaker treatment, there was an average of between 25 and 30 per cent of Calandra stages alive. The corn was leveled off in the cribs and covered with a special waterproof, and apparently gas-tight, tarpaulin in each crib before the di-sulfid was applied. A recording thermograph and hygrograph was placed near the middle of one mass of corn to give those records for a week following the application. When all preparations had been made, "Fuma" carbon di-sulfid was applied in various cribs at the rates of 3, 5, 6 and 8 pounds per 1,000 cubic feet. The liquid was poured directly on to the corn, the tarpaulins spread over it as quickly as possible, and the doors, which had been previously padded, were closed and nailed tightly. To insure still further tightness around the doors, papers were pasted over the entire door and frame to each crib. The only possible escape for the gas in these treatments would seem to have been around the edges of the room between the tarpaulin and the wall and upward and outward along the eaves. Subsequent examinations showed that the temperature at the time of beginning the experiment was between 57 and 58 degrees F., with the humidity averaging about 60 per cent. During the week after the treatment was made, both temperature and humidity arose steadily and gradually to a maximum of 63 degrees F., and 77 per cent humidity for the middle portion of this mass of corn. Under these conditions, a brief consideration of the results may be of interest. The examinations entailed a large amount of routine work, which could not be avoided on account of the necessity for determining the effect upon immature stages as well as upon adult insects. In the crib where but 7 per cent of Calandra stages were alive at the middle of October, there was about 32 per cent of living stages by the first of December in spite of the application of 8 pounds per 1,000 cubic feet. Similarly, in the other cribs, the percentage of living stages had largely increased before the examinations were completed. As a whole, it must be admitted that the treatments yielded very disappointing results, and in comparison with the fair degree of effectiveness of the treatment made at the middle of September, the principal varying factor which may offer a basis of explanation again seems to be the difference in temperature prevailing at the time the treatments were applied (57 vs. 80 degrees F.).

In another place where corn was stored, in one corner of a barn, the

cracks were battened with lathing nailed as tightly as possibly along them and partitions of matched boarding constructed so as to form three adjacent sections, each containing approximately 100 cubic feet. This corn had but recently been husked and placed in storage, and practically all weevil stages present were alive. Temperature and humidity records were kept here also. To add if possible to the tightness of the room, gas-tight tarpaulins were hung outside the walls, reaching from a height above the level of the corn to the ground. The corn was also covered with a similar tarpaulin. In this case Fuma di-sulfid was applied at the rates of 10, 15 and 20 pounds per 1,000 cubic feet. The temperature at the beginning of the treatment stood at 47 degrees F., but fell during the next two hours to 35 degrees.

During the succeeding thirty-six hours after this minimum was reached, it rose gradually and steadily to a maximum of 55 degrees, from which point it again fell to 35 degrees and subsequently two minimums of 32 degrees were reached with the maximum never exceeding 53 degrees. The unusually low temperature prevailing is doubtless sufficient explanation for the fact that in none of these sections was there more than 15 or 20 per cent mortality among the adult weevils, even where the largest dosage was applied. In conclusion, it would appear that the important results obtained from these experiments are as follows:

Grain infesting insects may be destroyed with carbon di-sulfid, cheaply and effectively, by even an application of 5 pounds per 1,000 cubic feet in exceptionally tight compartments, while the temperature is above 70 degrees F. It requires but a few hours to kill the weevils if a strength of gas equal to one quarter of a saturated atmosphere can be maintained, and provided the temperature is high enough to insure a considerable degree of vital activity on the part of the insects. Fumigation work with temperatures ranging below 60 degrees F. appears to be largely ineffective and inadvisable. Particularly in the Southern States, it would be possible to make the applications so that the temperature during the next few hours will average above 60–65 degrees. While the results obtained have been in some degree disappointing, we believe that they indicate a possible basis of explanation for variation in the effectiveness of treatments that have been reported in the past. They also show that the conditions under which each application is made constitute a problem by itself, and there is reason to feel that we may ultimately understand the influence of the many factors involved sufficiently well to enable us to adjust our methods of treatment so that they may produce more uniform and more satisfactory results. In spite of the many drawbacks to the common use of

carbon di-sulfid as a grain fumigant, we know of nothing equally effective which may be used any more satisfactorily. At the most, the expense of treatment will average less than a cent per bushel, and this is a very small cost to greatly lessen, if not entirely prevent, insect injury and the loss of from 25 to at least 65 per cent of the real value of corn, which must be stored for a period of several months in the Southern States.

Mr. Headlee: I have taken great pleasure in listening to this paper, for it seems to me that Doctor Hinds has hit upon the proper method of investigating the effect of gases on this insect. He has taken into consideration the difference in temperature and has probably considered the effect of moisture. It seems to me that we are coming to a time when the measures for the control of injurious insects must not only be based on a fundamental knowledge of their life economy in relation to the environment in which they live, but the relation of the measures themselves to the environmental conditions under which they will be applied must be fundamentally investigated.

The work of which we have just heard is a long step in this direction. The fundamental investigation of the life economy and measures of controlling seriously injurious insects in relation to environmental conditions is one of the most promising lines open to the economic entomologist.

I noted a few points which I would like to ask about. Is the rice weevil the largest destroyer of corn in the South? I raise that point for the reason that in south Kansas the Angumois grain moth seems to do the most damage to stored corn. Doctor Hinds did not report on the effect of moisture, and I would like to know whether in his opinion it had any important part in his results.

Mr. R. I. Smith: There is one thing, I think, Professor Hinds would have explained, if he had taken time. He said that in one experiment he found nearly 7 per cent of the weevil stages alive, and that the same grain, after receiving a second treatment in October, a month or six weeks later, with a greater strength, showed 38 per cent of the weevil stages alive. Of course, that seems very contradictory and inexplicable, but as I made some tests along this line last year I would say that the weevils which remained alive after the first treatment in September would account for the increase. They certainly do multiply rapidly.

I would like to ask in what way he determined the percentage of live weevils which has been shown in the results.

Mr. Hinds: In most cases a period of at least a week elapsed be-

tween treatment and the time the examinations were made. It is a very slow process to make the necessary counts.

In regard to moisture, I consider that we have more to investigate in this dirction, but we have not found as yet that moisture has anywhere near the same importance as temperature.

MR. R. I. SMITH: The results of Professor Hinds' experiments would indicate that the fumigation with carbon bi-sulphide in the case cited was not successful. The corn only slightly infested with weevils in September showed after a second treatment in October 38 per cent of weevil stages alive. Most farmers think that the fumigation is worthless unless they secure better results than this. In case a fumigation kills 90 or 95 per cent of the weevils, and then two months later the few remaining alive increase to considerable numbers, it gives the farmers the impression that the treatment was worthless.

My reason for making this statement is not to reflect on Professor Hinds' statement, but simply to explain the farmers' point of view.

PRESIDENT BRITTON: We will now hear a paper by Prof. R. A. Cooley, Bozeman, Mont., on "Notes on the Oyster Shell Scale in Montana."

NOTES ON SPRAYING EXPERIMENTS FOR THE OYSTER SHELL SCALE IN MONTANA

By R. A. COOLEY, *Montana Agricultural Experiment Station*

During the past ten years the oyster shell scale (*Lepidosaphes ulmi* L.) has been gradually increasing in the apple orchards in the river valleys in the western part of Montana. By the year 1907 it had come to be regarded by the apple growers as rather a serious pest and perhaps a menace to the orchard industry in the Bitter Root valley and around Flathead lake. In some orchards, particularly in those that have been more or less neglected, the scales now occur in notable numbers, encrusting the limbs and branches almost completely, and even extending down on to the main trunk, where great numbers become fastened under the loose scales of bark. Much fruit has been blemished and rendered unsalable by the insects attaching to it, and the stems of the apples are often more or less completely covered.

We have repeatedly recommended the use of kerosene emulsion, applied as a spray at the time of hatching, but growers have reported that no success followed the treatment. We also recommended limesulfur solution as a winter treatment.

Several years ago, in 1903, on April 21 and 22, lots of seven to nine apple trees in the orchard of Mr. Delaney, at Lo Lo, Montana, were

sprayed with different lime-sulfur solutions. Two subsequent visits were made to the orchard, one before the hatching of the eggs and one after, and we were unable to detect that any good had been done.

During the past three years we have received several reports from practical fruit growers that attempts to kill the scale by winter applications of lime-sulfur solution have not been successful. However, we also have received reports of success.

It was, therefore, apparent that an investigation and spraying tests were necessary. Accordingly a series of tests was arranged and carried out in 1909. The orchard that was selected for the experiments is located at Lo Lo and owned by Mr. Fred Gilbert. It is in sod, composed of old trees, and with a number of varieties. The trees had been cut back and pruned, and as the scale was abundant and fairly evenly distributed, the orchard was quite satisfactory for our purposes.

In spraying the trees we desired not only to find an insecticide that would kill and be generally satisfactory, but also to discover just how and when the insects or the eggs were killed. We hoped to find an explanation for the apparent lack of uniformity of results with the use of the lime-sulfur solutions, and remedies for use before the opening of the buds as well as after the hatching of the eggs in June. We therefore conducted a part of our tests on April 17 and 19, before the leaf buds had opened, and then waited for the appearance of the young. Hatching began on June 10, was well under way by June 14, and practically completed by June 20. The spraying for the hatched insects was divided into two series, the first being applied in the early part of the hatching period and the second in the latter part, for we desired to know whether the summer treatment, to be successful, should be applied at any particular time during the hatching period. Certain lots of trees were therefore sprayed on June 14 to 17, and others on June 21 to 23.

For convenience the various tests are here tabulated, with the results, as follows:

I

First series applied before hatching and before the buds had opened, and intended to kill the insect in the egg stage. Spraying done April 17–19.

1. Linseed oil emulsion, one gallon to nine of water.

Raw linseed oil	1 gal.
Hard soap	½ lb.
Water to make	10 gal.

The emulsion was made as with kerosene emulsion, excepting that a larger volume of hot water was used. The churning was done with the power sprayer by shutting the valve into the supply pipe and forcing the mixture through the overflow pipe back into the supply tank. A violent churning was so produced.

Several microscopical examinations made up to the time of hatching showed no apparent results. Examinations made while hatching was under way showed that many eggs had turned light brown and were shriveled and stuck one upon another and upon the bark and sides of the parent scale. Living larvæ could be seen vainly attempting to extricate themselves from the adhering mass of eggs. Practically no young attached to the bark and formed scales. Subsequent examinations showed that the treatment had been very effective. No injury was done to the trees.

2. Undiluted kerosene.

Designed to test the ultimate killing power of kerosene and not thought of as a practical remedy.

A considerable number of scales were loosened and dropped to the ground—probably about one third—but the eggs under those left on the tree hatched and the young developed normally. The trees were late in putting out foliage and were injured.

3. "Rex" lime-sulfur solution, one part to six of water.

Repeated microscopic examinations made up to the time of hatching showed no visible effects on the eggs. Moreover, the eggs hatched in a normal manner, and the empty egg shells could be found under the old scales later in the summer, but very few of the young ever attached to the bark, or, if they did attach, they soon loosened and dropped. The treatment was, therefore, effective and satisfactory.

We were able to find practically no difference in the results obtained from the use of "Rex," "Niagara" and home-made lime-sulfur solutions, nor were the greater strengths more effective. All showed good and satisfactory results.

4. "Rex" lime-sulfur solution, one part to eight of water. See results under No. 3.

5. "Rex" lime-sulfur solution, one part to ten of water. See results under No. 3.

6. "Rex" lime-sulfur solution, one to six, with three pounds lye

added to 50 gallons of the mixture. See results under No. 3. No advantage was detected from the use of lye.

7. "Niagara" lime-sulfur solution, one part to six of water. See results under No. 3.

8. Home-made lime-sulfur solution. See results under No. 3.

Lime	1 lb.
Sulfur	1 lb.
Water	2 gal.

9. Home-made lime-sulfur solution. See results under No. 3.

Lime	1 lb.
Sulfur	1 lb.
Water	3 gal.

10. Lye solution. Very little benefit was derived from this treatment.

Lye	1 lb.
Water	3 gal.

11. Lye-sulfur solution. Prepared as with lime-sulfur solution; cooked until the sulfur was all dissolved. The results were not convincing; some good was done.

Lye	1 lb.
Sulfur	1½ lb.
Water	3 gal.

12. Pratt's "Scalecide," one part to ten of water.

Before hatching time the eggs showed an oily appearance but hatched normally. Some scales were loosened and dropped off, though a smaller proportion than with undiluted kerosene, as reported under No. 2. Not a satisfactory treatment.

13. Whale-oil soap solution, one pound to one gallon of water, applied hot. Apparently this treatment had no effect.

II

Second series applied early in hatching period. Desired to be effective in killing young that had hatched and those about to hatch. June 14–17.

14. Pratt's "Scalecide," at rate of one to fifty.
A small percentage of the young lice were killed. Not a satisfac-

tory treatment. Very distinct, though not extensive injury to the foliage.

15. Pratt's "Scalecide" at rate of one to seventy-five. Same results as with No. 14, but with less injury to the foliage.

16. Linseed oil emulsion, prepared as for test No. 1.

Raw linseed oil	1 gal.
Hard soap	1 lb.
Water to make	12 gal.

Practically all the lice were killed, and the treatment was considered very satisfactory. This and the cottonseed oil emulsion treatments were considered to be the most satisfactory for summer use. The trees were not injured.

In connection with judging the results of this treatment we should mention that the Board of Horticulture sprayed a neighboring orchard with linseed oil emulsion, independent of the writer's experiments, on June 24 and 25. The scales were all killed and a small amount of injury was done to the foliage. Other trees were sprayed by the board with cottonseed oil emulsion, resulting in a killing of all the young scales, with less injury to the foliage.

17. Cottonseed oil emulsion. Prepared as with linseed oil emulsion.

Cotton seed oil	1 gal.
Hard soap	1 lb.
Water to make	12 gal.

Results were practically the same as with linseed oil emulsion summer spray. No injury to foliage.

18. Kerosene emulsion, one part stock emulsion to twelve of water. Very few, if any, of the scales were killed.

19. Whale-oil soap solution at rate of one pound to eight gallons of water, applied warm. A few, possibly 10 to 15 per cent, were killed.

20. "Rex" lime-sulfur solution, one part to fifteen of water. The treatment was unsatisfactory, very few young being killed.

21. "Self-boiled" lime-sulfur solution. Practically no good was done.

Lime	15 lbs.
Sulfur	10 lbs.
Water	50 gal.

22. "Blackleaf" tobacco extract, one part to fifty of water. We were surprised to find that this treatment was of very little benefit.

23. "Orwood" tree spray, one part to twelve of water. Apparently useless for this purpose.

III

Third series, applied late in hatching period. Desired to be effective in killing all the living young. Sprayed June 21 to 23.

24. Pratt's "Scalecide," one to fifty, using same trees as test No. 14.

This treatment did very little good. A high percentage of scales developed on trees sprayed twice during hatching time.

25. Pratt's "Scalecide," one to seventy-five, using same trees as test No. 15. Results same as under No. 24.

26. Linseed oil emulsion, using one gallon raw oil to fifteen gallons water. Seven out of the nine trees used in test No. 16 were used.

Probably no good was done by the second spraying during the hatching period, as the two trees left untreated under this number showed practically the same results as under No. 16.

27. Cottonseed oil emulsion. Repetition of treatment on trees used in test No. 17.

It is not clear whether this second treatment was beneficial, as, through an error, no trees were left unsprayed, as under No. 26.

28. Kerosene emulsion, one part of stock emulsion to twelve of water. Same trees used as in test No. 18. Very few, if any, were killed.

29. "Rex" lime-sulfur solution, one part to fifteen of water. Same trees used as in test No. 20. There was practically no benefit from this treatment.

30. "Blackleaf" tobacco extract, one part to fifty of water. Same trees used as in test No. 22. Practically no good was accomplished with this treatment, as with No. 22.

31. Linseed oil emulsion, one part to fifteen parts of water. A fresh lot of trees was used in this test.

The results under this number are doubtful, as it was later learned that the trees, which were in another orchard, had been sprayed in the spring with another insecticide.

In all of these tests a small power sprayer owned by the Montana State Board of Horticulture was used. A representative of the board, under the pay of the board, did the actual spraying, under my direction. The board also furnished practically all the material and supplies used in these experiments. It gives me pleasure to express my appreciation of the assistance and courtesy extended by the Board of Horticulture, through Mr. M. L. Dean, state horticultural inspector.

In conducting the work twelve trips to the Bitter Root valley were made, as follows: March 25–28, April 17–19, April 24–25, May 6–8, May 18–21, May 31–June 1, June 10, June 14–17, June 21–23, July 12–16, August 26–27, October 4–7.

Even under ideal conditions in orchards selected for such tests, it would be impossible to make entirely reliable statements concerning the comparative benefits following different treatments. We found that certain of the oily insecticides, applied before hatching of the eggs, caused a part of the scales to drop off, but it was impossible to determine what proportion had dropped. It would have been of some value if we had given the various trees a rating designed to indicate the comparative degree of infestation before the treatment, although on trees of which we made microscopical examinations and counts such a rating would have been of but little value, for the examinations were made on small twigs, which naturally would not conform closely to a tree rating. In examining the scales on the twigs we found a Zeiss binocular microscope of great service. Besides using it as a dissecting microscope we took off the lenses, with the mountings, and used the detached part in the hand, as with a field binocular.

The apparently conflicting results following the use of lime-sulfur solutions for this insect while the trees are dormant are striking. It is possible that differing weather conditions may explain the killing at one time and failure to kill at another. It is well understood that the sulfur compounds deposited upon the trees by the spray are acted upon chemically by the carbon dioxide of the air, resulting in the liberation of the gaseous sulfureted hydrogen and leaving on the tree pulverulent deposits of finely divided free sulfur and calcium carbonate. It has been shown on a previous page that this insect is killed by the winter application of lime-sulfur solutions only after the eggs hatch. It seems clear that the actual agent in the killing of the young, tender lice is the free sulfur resulting from the decomposition of the sulfur compounds. This decomposition has all taken place long before the hatching of the eggs. Therefore it seems possible that con-

tinued rain storms may so reduce the amount of free sulfur on the bark as to render the treatment harmless to the insects.

Further work on the subject will be done in the season of 1910.

From the foregoing two interesting points are apparent:

(a) Eggs of the oyster shell scale are unaffected by the application of lime-sulfur solutions made previous to the opening of the buds. On trees so sprayed the young were killed very soon after hatching. The intervention of rain storms before the hatching of the eggs may more or less affect the value of the treatment.

(b) It is indicated that emulsions of linseed oil and cottonseed oil may be useful for the treatment of this insect while in the egg stage and during the hatching period.

Mr. Braucher: Some years ago I was engaged in spraying work in Lincoln Park, Chicago, and secured practically the same results that Professor Cooley has indicated. The eggs of the insect in many cases appear to be perfectly normal up to the time of hatching, but in most cases the young failed to establish themselves, and later in the season I was unable to find living insects on the trees.

The home-boiled lime-sulfur wash was used, being applied from November until early spring, and gave satisfactory results.

Mr. Surface: I have found several cases in Pennsylvania where this insect has been practically exterminated by using the lime-sulfur wash. This was used in the orchard of Mr. Robert Beaston, at Tyrone, Pa., with excellent results.

[The Proceedings will be continued in the next issue.—Ed.]

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

In accordance with the provisions of the constitution, the President has appointed the following Committee on Membership for the year 1910: Prof. H. E. Summers, Prof. A. L. Quaintance and Dr. S. A. Forbes.

E. D. Sanderson, President.
A. F. Burgess, Secretary.

Proceedings of the Eighth Annual Meeting of Horticultural Inspectors

The eighth annual meeting of the Association of Horticultural Inspectors was held in the Copley Square Hotel, Boston, Mass., December 27th and 28th, 1909.

For convenience the business transacted at the meeting will be reported first, which will be followed by the papers and discussions.

PART I

The meeting was called to order by President F. L. Washburn at 2 p. m., Wednesday, December 27th, in the lecture hall at the Harvard Medical School. In the absence of Secretary T. B. Symons, the President appointed E. F. Hitchings of Maine to act as Secretary *pro tem.* A good attendance of members of the Association and visitors marked each session of the meeting. Among the Inspectors present during the meeting were:

F. L. Washburn, St. Anthony Park, Minn.; J. B. Smith, New Brunswick, N. J.; H. E. Summers, Ames, Iowa; G. G. Atwood, Albany, N. Y.; Franklin Sherman, Jr., Raleigh, N. C.; N. E. Shaw, Columbus, Ohio; H. A. Surface, Harrisburg, Pa.; E. B. Engle, Harrisburg, Pa.; J. L. Phillips, Blacksburg, Va.; E. L. Worsham, Atlanta, Ga.; P. J. Williams, Auburn, Ala.; L. R. Taft, East Lansing, Mich.; S. A. Forbes, Urbana, Ill.; A. E. Stene, Kingston, R. I.; J. E. Stewart, Morgantown, W. Va.; W. E. Rumsey, Morgantown, W. Va.; C. P. Gillette, Fort Collins, Col.; T. J. Headlee, Manhattan, Kan.; S. J. Hunter, Lawrence, Kan.; E. F. Hitchings, Augusta, Me.; L. M. Peairs, College Park, Md.; E. D. Sanderson, Durham, N. H.; W. A. Thomas, Clemson College, S. C.; W. E. Britton, New Haven, Conn., and P. L. Huested, Albany, N. Y.

The American Association of Nurserymen was represented by Messrs. William Pitkin and Irving Rouse of Rochester, N. Y.

In opening the meeting, President Washburn reviewed the work of the Association and pointed out the need of more thorough organization and the desire of the inspectors that the proceedings of the meeting be printed.

These subjects were discussed by the members; the matter of having a stenographic report of the meeting and proceedings printed was referred to the following committee:

W. E. Britton, Chairman; C. P. Gillette and H. E. Summers, which committee later reported as follows:

REPORT OF COMMITTEE ON PUBLISHING PROCEEDINGS

Your committee recommends that the Association hereafter employ a stenographer to report the proceedings of the annual meeting, and these proceedings, after being edited by the outgoing Secretary, shall be printed and distributed to members of the Association. The expense incurred for such stenographic service, printing, etc., shall be met by an assessment levied pro rata on each state, territory or Dominion of Canada, represented or desiring representation in the Association: provided that by reason of the law of such state or territory the ruling of boards of audit prevents their paying the assessment due, such deficit shall be apportioned pro rata among the other states, territories and Dominion of Canada. The failure of any state or territory to be able to share its burden of expense shall not prevent its representatives participating in the meeting.

W. E. Britton,
H. E. Summers,
C. P. Gillette,
Committee.

Question No. 19 on the program, in regard to the desirability of having a more regular organization, was fully discussed and referred to the following committee to report at the next annual meeting:

Committee on Organization: Messrs. G. G. Atwood, S. J. Hunter, H. A. Surface, W. E. Rumsey and T. J. Headlee.

Mr. A. F. Burgess read a letter from the United States Consul at Belgium in regard to the certification of imported nursery stock from that country. The letter was referred to a committee, composed of J. B. Smith, chairman; G. G. Atwod, S. A. Forbes, which committee reported as follows:

REPORT OF COMMITTEE

Your Committee on the Advisability of Securing Consular Certification to Foreign Certificates reports that in its opinion this Association should favor any method that would tend to secure proper inspection or that would add to the value of certificates. It feels, however, that the value of a certificate depends primarily upon the standing and official position of the individual making the inspection, and that no consular certification can add to this value.

It recommends, therefore, that no action requiring consular certification to inspection certificates be taken.

J. B. Smith,
G. G. Atwood,
S. A. Forbes,
Committee.

The report of the Committee on General Principles governing the Association was submitted by Chairman J. B. Smith.

After considerable discussion, the following was adopted by the Association:

REPORT OF THE COMMITTEE ON GENERAL PRINCIPLES GOVERNING THE ASSOCIATION

1. The first and principal duty of the horticultural inspector is to his constituents, the farmers and fruit growers of his state.

2. Inspection, quarantine and similar laws are passed for the protection of these interests, and so far as the inspector is charged with the enforcement of the laws he must keep in mind always their purpose, no matter what the effect may be on other interests.

3. The inspector owes the nurserymen whose stock he inspects fair treatment and all the consideration that the law allows him to accord, but nothing else.

4. The inspection laws, although meant primarily to protect the horticultural and agricultural interests, are not intended to injure the nursery interests, and they should never be made to bear any more severely upon growers of stock than is absolutely necessary.

5. Between the honest nurseryman and the inspector there should be coöperation and an attitude of helpful interest on the part of the former.

6. The dishonest nurseryman, or one who wishes to dispose of questionable stock to avoid loss, deserves no consideration whatever.

7. The Association of Horticultural Inspectors is a voluntary one, and its members are bound by none of the actions taken at the meetings except as they approve themselves to their judgment.

8. The relation between the members is that of colleagues or comrades engaged in efforts to the same end, under different conditions, seeking mutual help and information, by free conference at the meetings.

9. As colleagues, each member owes to every other member frankness, honesty and a belief that every man is doing the best he can under his circumstances, and that his certificates are honestly given, and state facts correctly.

10. Each member recognizes the possibility of error in his own work and in that of others, and recognizes also that the receipt of a parcel of infested stock bearing a certificate is not necessarily evidence of either carelessness or lack of proper system on the part of the inspector whose certificate is attached.

11. Each member, whenever he gets track of a parcel of infested stock bearing the certificate of a fellow member, owes it to that fellow member to notify him immediately of all the facts in the case, that an investigation may be made by the inspector concerned and a continued misuse of his certificate prevented.

12. Whenever any inspector has reason to believe that any nurseryman in his state is willing to run risks of shipping stock not suitable for interstate trade into another state, it is his duty to warn the inspectors of neighboring states into which he has reason to believe stock may be sent, that stock from such nursery is open to suspicion.

13. It is the duty of every member of this Association to answer frankly and freely every question asked by a fellow member concerning nurseries or other conditions in his state, and it is the duty of the member so informed to consider this information as confidential and not for publication.

14. In case at any time a certificate be withdrawn or a nurseryman hold-

ing a certificate be detected in dishonest or questionable practice, notice of such withdrawal shall be at once sent to every other inspector within the region where such nurseryman is known to trade, and notice of such dishonest or questionable practice shall be given to all inspectors in states likely to be affected by such practices.

15. In this Association the rule that should goven all members is, Do unto the others as you would that the others should do unto you.

JOHN B. SMITH,
H. T. FERNALD,
AVON NELSON,
FRANKLIN SHERMAN, JR.,
F. L. WASHBURN,
Committee.

The following resolution, offered by Mr. J. L. Phillips, was endorsed by the Association:

Resolved, That no certificate should be used on any nursery stock that is infested with San José scale, badly deformed by Wooly aphis or diseased with Crown gall.

In concluding the discussion of question three on the program, Mr. T. J. Headlee moved that a committee of three be appointed by the chairman to investigate the different means of treatment of infested nursery stock in different states, and to recommend to inspectors a tentative method of procedure by which infested nurseries are to be handled, also methods of treatment of imported nursery stock.

The chairman appointed Mr. Franklin Sherman, Jr., E. L. Worsham and J. L. Phillips.

The Committee on National Legislation, through Professor Sanderson, reported a proposed bill[1] which had been agreed upon at a conference with the representatives of the Nurserymen's Association and the chairman and some members of the Committee of the Pomological Society to consider this matter. The principles of the bill were endorsed by the Association, and it was moved and carried that the chairman appoint a committee to make such changes as may seem necessary; the committee to confer with the committees of American Nurserymen's Association and American Pomological Society, respectively, and make every effort to have the same passed by Congress.

The chairman appointed Messrs. T. B. Symons, E. L. Worsham and G. G. Atwood.

The selection of officers for the ensuing year resulted in the re-elec-

[1]A copy of the revised bill will be published in a subsequent issue of the JOURNAL.

tion of the present ones: F. L. Washburn, St. Anthony Park, Minn., President; T. B. Symons, College Park, Maryland, Secretary.

The following resolution offered by the Secretary was endorsed by the Association:

Resolved, That this Association hold at least three sessions at its annual meetings, such sessions to be arranged with as little interference with allied associations as possible.

There being no further business, the meeting adjourned.

Note: The Secretary desires to express his appreciation to Mr. E. F. Hitchings for his kindness in making notes of the meeting prior to his arrival.

PART II

President F. L. Washburn, in opening the session of the meeting Monday afternoon, made the following remarks:

THE WORK OF THE ASSOCIATION OF HORTICULTURAL INSPECTORS

By F. L. Washburn, *St. Anthony Park, Minn.*

Gentlemen: What I have to say is hardly to be dignified with the name of an address, but rather an appeal to the members of the Association to stand together as a unit in endeavoring to perfect inspection laws and other conditions of inspection which tend to promote the best interests of good horticulture in the United States.

You will join me, I am sure, in complimenting our Secretary upon his enthusiasm and upon the faithful discharge of his duties during the last year, and also upon his location, so near the center that it affords him additional advantages in forwarding the work.

The growth and importance of this work, the need of better organization and better financial facilities, is perhaps the most important question before us at this meeting.

An impetus to our work has arisen in the danger contained in imported stock, and the additional work put upon the inspectors in the various states on this account is no mean factor. When as inspector for Minnesota I was asked to look after this stock, I had no conception of the amount of foreign material shipped into my own state, and have been astonished at the enormous number of plants brought into Minnesota from Holland and France in some instances, like the box-elder, for instance, trees which are commonly raised in our state, but which nurserymen find it cheaper to buy in Holland than to raise

at home. The indifference of florists and nurserymen in connection with this necessary inspection of foreign stock is to be deplored, and there certainly is need of a clause in the law, if we have a Federal inspection law governing importations, obliging these parties in the interest of the welfare of horticulture, to notify their various inspectors of the arrival of foreign stock which has not previously been inspected in this country. While I believe we, as inspectors, are not at all unanimous in desiring uniform inspection laws throughout the country, nevertheless if it were possible to have Federal laws supporting this body in its resolutions, and its members in their work in their various states, I believe it would add dignity to the work and relieve us of much embarrassment. It is almost impossible, with the business interests in a state so antagonistic to progress along these lines, to pass state laws stringent enough to fit the needs of the situation.

Closely allied to the need of strengthening our work and our position in the various states is the demand for publishing the proceedings of our meetings. This calls for money; not much, however. At the suggestion of our Secretary I sent out circular letters to all of the inspectors, asking them if their departments or their various boards of control would countenance an annual assessment to this end, and it was with pleasure that I learned from many that they can promise this financial support. Almost all of them from whom I have heard say they are quite positive their various boards will allow it, and some give positive assurances to this end. I trust there are many here from whom I have not heard who are attending the meeting with the same favorable answer to the proposition.

There are various points in connection with the work upon which I feel keenly, and which I should like to discuss, but our program is a long one, and these various points I have in mind are either on the list of subjects for discussion, or will come up naturally in the remarks following the various papers to be presented.

Each and all of us come in contact more or less with the apathy or indifference on the part of nurserymen, until their business is affected. I venture to assert that if a copy of our program were sent by each one of you to each of your constituents, asking for some comment, or some suggestions to be presented to the meeting, that a very small fraction of your nurserymen would take the trouble to reply. Now, I believe if we had Federal authority behind us, not in the matter of uniform laws regarding fumigation and other details not demanded by every state, but uniform laws regulating our relations to the nurserymen, and the relations of the nurserymen to us, this evil in a measure would be corrected.

It is reported that the American Association for the Advancement of Science meets in Minneapolis in the winter of 1910, and I suppose that this Association will also meet there. If it is definitely decided that such be the case, you must remember that you are coming into a cold country, though a beautiful one, and I wish to assure you that although the temperature is low, the hearts of the people are warm, and we will do all we can to make you feel at home, and to repay you for the journey.

A discussion of the points suggested in these remarks is noted in Part I.

A paper was presented by Mr. G. G. Atwood.

BROWN-TAIL MOTH ON IMPORTED NURSERY STOCK

By G. G. Atwood, *Albany*, N. Y.

On the 1st of January, 1909, information came to the Department of Agriculture in Albany that brown-tail moths in the usual winter form of nests had been found in a recent importation of nursery stocks from France. The great importance of this discovery was at once appreciated by the Commissioner of Agriculture, who by statute is charged with the responsibility of preventing the introduction of "dangerously injurious insect pests" into the State of New York. We knew that extensive importations from France and other countries were due to arrive during the months of January, February and March, and furthermore that the millions of stocks and seedlings were for planting in nearly every nursery in the state. A circular of information calling attention to the conditions confronting us was distributed to all our nurserymen and planters and they were directed to notify the Department of the arrival of any importations of stock from abroad and requested to hold all boxes unopened until an inspector of the Horticultural Bureau could be present. Fortunately, we had for years previous a requirement of law by which transportation companies bringing nursery stock into the state must notify the Department of their having in their possession any such shipments and giving names and addresses of consignors and consignees, together with such other information as might be required. Special requests were at once made of the sixty odd transportation companies to heed the letter of the law.

We further asked and received the coöperation of Custom House brokers, securing from them much information, particularly in refer-

ence to boxes imported, names of consignees, number of boxes, names of transportation companies receiving the boxes, and dates.

By direction of the United States Secretary of the Treasury, Collectors of Customs in the eight ports of entry within the state were authorized to give our Department of Agriculture the information required to enable us to locate importations and their destination. By courtesy of the Naval Officer in New York City, where the bulk of importations were cleared, we were permitted to place an agent who copied such portions of every manifest for our use as needed.

The Department had a dozen trained inspectors available, to whom additional help was given as required. All were placed in sharp communication to facilitate inspections and avoid delay and exposure to seedlings.

Our inspectors were directed to locate and burn at once all nests of brown-tail moths found. No one was permitted to save, handle or give away any specimen nests. Boxes in which nests were actually found were at once burned, together with all moss, packing materials and linings. Subsequent examinations of all cellars and shops where imported stock was handled were made and all trimmings were carefully collected and burned. Early in the month of January we found that wherever infested stock was unpacked in a warm room the larvæ would leave their nests and not return as they do in the open. They would soon cover themselves with their silken threads wherever they found lodgment.

To discover and burn all nests required a very careful seedling to seedling inspection, especially with branched or bushy plants. Even the roots needed to be carefully examined for any nest or portion of nests that might have been torn off and dropped into them. The custom of packing seedlings not tied in bundles placed tops and roots in layers caused a distribution of nests through the boxes containing from 3,000 to 15,000 seedlings each. All such inspection was comparatively simple, until we learned the habits of the escaped caterpillars, after which an inch to inch inspection was pursued. At this stage, of course, careful fumigation of all stock with hydrocyanic acid gas appeared feasible, but to our disappointment we found that the use of a formula of four or five times such strength as is used for San José scale, with long time exposure, was ineffective. The young larvæ were not all killed. With more time and many more experiments we do not find yet that fumigation can be relied on. All stock from boxes in which nests were found were ordered dipped in miscible oil at portions of 1 of oil to 20 of water. This proved effective, and if a weaker mixture would accomplish the desired results we should like to know it.

In the mass of reported shipments that came to our office while we were receiving daily reports of the discovery of a large number of insects by our inspectors, we at the same time had knowledge of large shipments of imported stock to nearly every state in the Union and to the Dominion of Canada.

Certainly we could not permit the establishment of brown-tail to the southwest and north of us. Therefore, in accordance with the usual custom of the members of this Association—the American Association of Official Horticultural Inspectors—we sent a statement of our findings to each inspector in the States and the Dominion, and also called attention to the apparent inefficiency of fumigation to destroy the tiny brown-tails.

This statement of information was followed by a prompt report to each state inspector on this continent of all shipments that our system gave us knowledge of. We have received from our correspondents candid acknowledgments and rejoice in the generous statements made by some that but for such reports as we were pleased to make them and the further caution relative to ineffective fumigation, we had undoubtedly been the cause of a successful control of the pest and possibly prevented the foothold it might have secured in a vast area of territory not yet infested.

The unprecedented import of brown-tails in the spring shipments of 1909 gave a fine opportunity to at the same time discover, if present, other pests, but there was little of importance found—I believe only a cluster or two of the eggs of the gypsy moth in a shipment to a sister state.

All plantings of foreign stocks or seedlings made in New York State have been carefully inspected for nests of brown-tail moths, and nowhere have we found that a single one has escaped our inspectors' diligence.

The finding of brown-tails in importations of nursery stock to New York in the spring of 1909 seems without precedent. One would think that having such a conspicuous nest that if seedlings bearing them had been brought here within the past forty years that some of the nurserymen or some of their many men who trim the seedlings leisurely in a warm, light shop one by one, in winter would have recollection of having seen such nests as cover this pest, but only one such case has come to light as a result of much inquiry, and in that case the identification is not conclusive.

Parenthetically I wish to digress from a strict adherence to my subject and speak of the only case of a brown-tail infestation that we had during the year. To a large private estate in Westchester County

a carload of cratægus was shipped late in the fall of 1908 from an eastern state. All the trees were heeled in over winter. In the spring the trees were planted in groups of 12 to 15 trees in an area of about 1½ acres. Later, about the time brown-tails pass to the pupæ, 17 caterpillars were found. It was then too late to spray with arsenical poisons, as feeding had ceased. We had no knowledge as to how many insects were present, but our only course to pursue was to destroy the pupæ wherever they might be and at the same time save the valuable thorns and the large shade trees nearby.

Following thorough inspection, all trees were sprayed two or three times with oil emulsions. The cultivated land and the heavy sod land (after the grass was cut, oiled and burned) was burned over with cyclone spray. Sixty or seventy barrels of crude oil were forced through suitable nozzles and the oil ignited at the end of the nozzle. The sod was burnēd black and the cultivated part was rolled and reburned. Some portions had three burnings. Entire success seems to have rewarded us, as acetylene gas trap lanterns kept going for ten nights at the right time for moths to fly caught no brown-tails, and subsequent inspection revealed no moths or nests to date.

The state Legislature in April saw fit to amend our horticultural inspection law when their attention was called to the possibility of brown-tail and gypsy moths becoming established in the state. Sufficient appropriations were provided, and the Commissioner of Agriculture was authorized to issue such orders as in his judgment were necessary to control in any emergency.

No box or package of nursery stock brought into the state can be opened without first obtaining consent of the Commissioner. Custom House brokers and importers are required to register their names and addresses in the Department office. They and transportation companies give such information as the Commissioner shall from time to time require.

Last spring custom house brokers were courteous and gave us lists of nearly all of their importations for this and other states, but now with a law to require information they hold, and justly so, that we are entitled to information only relative to stock for New York State.

The following is a summary of the work performed on imported nursery stock:

NUMBER OF SHIPMENTS AND BOXES REPORTED BY THIS DEPARTMENT TO OTHER STATES

State.	No. of shipments.	No. of boxes.	State.	No. of shipments.	No. of boxes.
Alabama	1	......	Nebraska	4	9
California	6	13	New Hampshire.	1	1
Colorado	5	7	New Jersey	111	3842 and 125 tubs
Connecticut	22	209 and 28 pckgs.	New Mexico	1	4
Georgia	1	2	North Carolina	1	1
Idaho	6	7	Ohio	56	284 and 12 tubs
Illinois	57	723 and 12 tubs	Oregon	2	2
Indiana	6	39	Pennsylvania	56	494 and 6 tubs
Iowa	11	52	Rhode Island	16	65
Kansas	9	30	South Dakota	1	7
Kentucky	6	33	Tennessee	4	11
Louisiana	2	7	Texas	2	11
Maryland	9	110	Vermont	2	8
Massachusetts	43	287 and 100 trees	Virginia	2	2
Michigan.	24	87	Washington	4	13
Minnesota	8	48	West Virginia	2	3
Mississippi	1	1	Wisconsin	5	15
Missouri	9	25	Canada	28	212
Montana	2	4	Washington, D. C	3	9
				529	6677 Pkgs. 283

NEW YORK

Number of shipments, 860.

3998 boxes	229 bales	33 bundles	185 tubs	121 baskets Total, 4566
Boxes burned, 707.	Bales burned, 2.		7,000 nests destroyed.	

We are nearly all of us under obligations to Doctor Howard for reports on shipments of imported stock. If the importations this winter prove to be free or partly free from brown-tails it will be largely the result of his visit to the entomologists in France.

No brown-tails were found on any stock except that grown in France.

We have inspected this fall hundreds of shipments from Germany, England and Holland and a very few from France and no pests have been reported. The bulk of stock used by our nurserymen for budding come from France, and most of it is received in the first three months of the year.

We are seemingly as ready for the work as is possible and shall

attack it with the hope of successfully delaying the establishment of the two dreaded pests in New York State.[1]

Considerable discussion followed this interesting paper by Mr. Atwood. Many members present expressed their obligations to Dr. L. O. Howard and Mr. G. G. Atwood for their great aid in notifying inspectors throughout the country of the arrival of shipments of imported stock to its destination.

Doctor Howard was asked to state the conditions as he observed them in Europe this past summer, and a brief of his remarks follows:

EUROPEAN CONDITIONS AS AFFECTING IMPORTED NURSERY STOCK

By L. O. Howard, *Washington, D. C.*

[Summary of remarks]

Doctor Howard referred briefly to the bill introduced at the last session of Congress regarding the inspection of imported nursery stock, and stated that during a trip to Europe in June last he had, at the request of the chairman of the Committee on Agriculture of the House of Representatives, made a cursory study of the methods of growing nursery stock for exportation to America in certain localities in Europe. He satisfied himself that the conditions in Holland are excellent and that the inspection certificates issued by Professor Ritzema Bos and his assistants can be relied upon so far as any inspection certificates can be relied upon. He found in France that conditions were bad. Nursery stock was grown in certain places quite to the borders of woods and of neglected edges, upon which he found larvæ of the brown-tail moth, the gypsy moth, of two species of *Hyponomeuta*, and other injurious insects not yet introduced into the United States. He found that the conditions under which certificates have been given heretofore in France were such as to render these certificates unreliable. He described an interview with the Director of Agriculture of France, Monsieur Vassiliere, and stated that the latter had promised him to establish at once a governmental inspection service in that country under the Ministry of Agriculture which would enable the issuing of such certificates as would guarantee freedom from insect pests in a satisfactory manner. This service, it was stated, would be placed under the directorship of Dr. Paul

[1]Large numbers of brown-tail moth nests are being found in shipments now arriving from France. January 29, 1910.

Marchal, who will be empowered to select his own inspectors. The speaker described a subsequent visit to England, where he interviewed members of the Council of the National Horticultural Trades Association of Great Britain and Ireland and also officials of the Board of Agriculture, and expressed the opinion that a governmental inspection system will shortly be started in England. While admitting that it is hardly to be expected that any inspection system will be absolutely perfect and thoroughly competent, an honest system will undoubtedly greatly reduce the number of injurious insects which can be imported into this country on nursery stock, and will, therefore, reduce the labor of inspection on this side. The remarks were illustrated by a series of enlarged photographs.

Evening Session, December 26th, 1909.

President Washburn presiding.

The following paper was read by Mr. N. E. Shaw, "Increasing the Demand for Orchard Inspection":

INCREASING THE DEMAND FOR ORCHARD INSPECTION

By N. E. Shaw, *Columbus, Ohio*

In addition to the annual inspection of nurseries, the Ohio law provides for the free inspection of any orchard in the state on petition by the owner or lessee of such premises, or of any orchard in dangerous proximity thereto.

The immensity of the nursery business in Ohio, and the inspection duties involved, in properly safeguarding purchasers of this stock, usually requires the entire time of the inspection force for about eight months of the year. As about two thirds of all stock grown in the state is shipped to other states, the majority of the benefits of our inspection do not fall to Ohio orchardists.

Vast quantities of stock enter Ohio from outside sources, and from certain quarters stock infested with San José scale has been repeatedly received. Practically every county in the state has an outbreak of this insect, and in a number of counties the infestation is general. The attack of San José scale and other orchard pests, together with general neglect, has brought family orchards throughout the state into a deplorable condition. The commercial orchardist is alert for any pest which may hinder the proper development of his product and needs but occasional assistance from us. It is the family orchard

which has been neglected, and in order to encourage better care of these places we have attempted to enlarge our inspection operations.

In view of the fact that inspections of such properties, and advice relative to their treatment, are made entirely free of charge, it has been a source of wonderment why more advantage has not been taken of this privilege. Until the present year an average of about one hundred petitions were received yearly, and these came largely from commercial orchardists, and from nurserymen for the purpose of having adjacent places properly treated. Careful inquiry into the matter has revealed the fact that many farmers, who do not pay particular attention to horticultural affairs, were not aware that such inspections are made free of charge, while many feared that wholesale destruction of trees followed these examinations. Unscrupulous fruit tree agents have largely been responsible for the latter impression, as such parties often wished to avoid, as far as possible, an examination of the stock sold by them.

A general inspection of the orchards of the state is out of the question with the present funds available for this work. If, however, we can make the demand for orchard inspection insistent enough, we feel sure that our legislature will be induced to provide ample funds so that sufficient aid may be given to all who desire to produce better trees and better fruit. To this end efforts have been made to place these opportunities before as many farmers of the state as possible.

County infirmaries of Ohio are usually provided with fair-sized orchards. Arrangements were made during the present year to hold spraying demonstrations at these places. The meetings were well advertised through county papers and mailing lists, and the orchards being centrally located a large attendance was invariably secured. A careful inspection of the orchards was made and different pests pointed out. Several trees were properly pruned, young ones being shaped in the way they should grow and old, large ones reduced and thinned in such a manner as to permit thorough spraying. Spraying solutions were next prepared and applied with a good spraying outfit suitable for use in family orchards. At the close of the meetings statements were made in regard to the value of orchard inspection and the advantage of a conference with an inspector relative to controlling the pests which might affect different orchards. Petition blanks were then given to all desiring them and an inspection promised after the receipt of these petitions.

A number of county agricultural societies in the state have signified a willingness to select orchards for the purpose of having demonstrations given, and as many of these meetings as possible will be held

during the coming year, following largely the same plan as that used at county infirmaries. By interesting these societies, whose duties usually consist in conducting county fairs, we hope to secure a better recognition of horticultural products by more liberal premiums for perfect fruit, thereby encouraging better care of the home orchard.

During the past summer an exhibit, consisting of destructive insects, diseases, nursery stock, affected fruits, spraying materials, nozzles, etc., was made at the state fair and one county fair. The interest taken by visitors required the constant attention of two men in explaining the different parts of the exhibit. The necessity for better care of orchards and the advantages of inspections were impressed upon all interested and petition blanks given to those desiring the same.

For the coming year, efforts will be made to visit as many county fairs as time and funds will permit. Almost every county of the state has a county fair, and a splendid opportunity is thus offered to bring our work before the people.

State Farmers' Institute speakers in Ohio are required to fully explain at each institute the work of the Division of Nursery and Orchard Inspection and the advantages of having orchards examined. Assistance is promised to beginners in spraying operations and all are urged to take advantage of these opportunities. As there are 325 institutes in the state, having an average attendance of 150, large numbers of farmers and fruit growers are reached in this manner.

We have on our files nearly 700 county and daily papers of the state, and the majority of editors are glad to publish terse statements relative to our work. It is our opinion and experience that more people can be reached by short items through the medium of county papers than through more extended articles in the agricultural press.

In all talks before farmers' institutes, farmers' clubs, granges and high schools the writer urges the necessity for better care of home orchards and ornamental plantings. Several high school superintendents have asked for spraying demonstrations before their students, and it is perhaps here that the greatest good along these lines can be accomplished. No set notions of long standing are encountered and great willingness is found to adopt and execute new ideas and methods.

That our demonstrations of last spring have accomplished results is very apparent from the demand for our work in those counties where these meetings were held. Quite frequently, when an inspector has been sent into these localities to make a few examinations, the requests for his services became so numerous that practically every place in the community was visited. From these counties we are sure of aid in

securing better recognition from our legislature, and will therefore be able to increase our operations along these lines.

It has been gratifying indeed to receive many letters from sections where spraying demonstrations have been given, speaking of the good results secured from the first attempts at spraying, and of plans to do the work more thoroughly in succeeding years.

Four times as many requests for our services have been received during the present year than in any one other year of the work. This encourages us to continue on a larger scale the methods in vogue.

Dr. J. B. Smith: I wonder how many of us have run across the same trouble that is mentioned in this paper; that is, the failure on the part of the orchardist to ask for an inspection. I know that this is the failing of a good many in New Jersey, and I wonder whether the accounts which were published at the beginning of this work concerning orchards, which we ordered to be taken up, has been gotten up in such a shape as to make it difficult for the true condition of the work to reach the farmers and fruit growers. Sometimes a statement of that kind is taken up by horticulturists, and it takes a long, long time to outgrow it. We find that difficulty in New Jersey.

If we had a law requiring an inspection of every orchard, it would greatly facilitate matters. We find a whole lot of people who are willing to take advantage of it.

Mr. Worsham: We notice that when a request is made for an inspection it is usually for an inspection of a neighbor's orchard. A man knows the condition of his own orchard, and he does everything in his power to increase its growth, but he usually comes around and makes a request for an inspection of his neighbor's orchard. We are aware of scale being present in most orchards, as it is in almost every fruit-growing section of the state.

Mr. Headlee: The Farmers' Institute in Kansas has a special agent connected with the Agricultural College, and has been able to engage a practical, up-to-date horticulturist. This man goes about doing their "Institute" work, and doing the same kind of work as mentioned by Mr. Shaw. The work which this man has to do is very interesting. As to the demands on his time as a consultant agent, he is not greatly in demand. The people do not realize as yet what good fruit growing means. We are educating them up to the point where they will realize it, and it is done through this Institute. This man goes to every county during the year, and comes in personal contact with the people, and in the next two or three years he will be so busy in this

line that he will not be able to do anything else. There are many townships in Kansas where you can raise orchards, but you would have to carry water in a tin dipper to wet them. It seems to me that we are just in the beginning of this kind of work. The Institute work in Kansas is entirely in charge of the Agricultural College. At the last Legislature $50,000 was appropriated for this purpose.

MR. HITCHINGS: This matter is of great importance to us at the present time, especially in Maine. With us, our "Institute" work is carried on by the Department of Agriculture, and we are holding some special "Institutes," followed by a week of fruit shows.

Some orchards have been inspected during the past few weeks. I had a man with me and we have noticed that the majority of the trees are covered with canker. The matter of holding entomological exhibits at county fairs is very important. We have furnished such exhibits for several years in our state, and at present the demand is greater than we can supply. I have three sets for such purposes, containing forty-eight mounts. We exhibited at thirty different fairs this past year, and did not nearly fill the demands.

In regard to orchard inspections, there is a great demand which we cannot fill. They do not know what to do with their orchards in Maine and are anxious to find out.

MR. TAFT: In Michigan the "Peach Yellows" has been known for twenty-five years and the "Little Peach" some fifteen years. So far as the state inspection goes, we do a large amount of work throughout the nurseries. The orchards are inspected by local inspectors. Three inspectors are appointed in each township, and we are fully satisfied that they are competent. It is often necessary to take new inspectors into the orchard for a day or more in order to point out the proper course to be pursued. In Michigan we bring the work of the "Institutes" and inspectors close together, and, furthermore, the appointment of the speakers at the institutes, as well as all the inspectors of the state, are in my own hands, and I am thus able to use quite a number of nursery inspectors as institute lecturers. They are competent to discuss fruit growing and matters of that kind, and in the spring months hold their demonstration meetings in the orchards. Many inspectors are very competent for this work.

We have several hundred townships where we have a board of three inspectors. It would not be possible for us to carry on this work with the state inspectors only.

We have four hundred and twenty-five "Institutes" throughout the winter, and perhaps sixty or seventy railroad "Institutes," and nearly all of these are well attended.

We have an expert fruit grower, and sometimes two, at each "Institute" to do the talking. Some of these men are practical horticulturists, while others have taken courses in horticulture and entomology at the Agricultural College.

NOTES ON THE STATE NURSERY LAWS OF OKLAHOMA AND THEIR EFFECT

By C. E. Sanborn, *Stillwater, Oklahoma*

The nursery inspection laws of Oklahoma as outlined at present are brief, but far reaching in effect. The nurseries of the state are the primary objects of this legislation, though injurious insects or diseases outside the confines of a nursery likewise come within the provisions of the act. Large discretionary powers are given the State Board of Agriculture, and the nurseryman is held responsible by law for selling inferior grades of stock and stock untrue to name.

Many nurserymen and especially agents from nurseries of other states have heretofore found it convenient and profitable to line out all stock held for sale but not disposed of in season, for the purpose of disposing of it the following or even the second following season. This sale of such trees as first grade stock is now declared illegal, since such lined out stock is of inferior grade. The benefit to the public accrues not solely by protection through elimination of "debilitated" stock, but also from the consequent elimination of an undesirable class of irresponsible nurserymen.

The protection of the law does not leave the nursery stock when the latter is shipped from the nursery, as many nursery laws do, but persists for a period of seven years, so that stock may have ample time to establish its identity. If true to name, it is exempt from legal penalty provided it is free from any injurious diseases or insect pests. This is true of all agricultural products, such as seeds, fruits, grains and vegetables.

The law protects horticultural and agricultural industries as above outlined. Furthermore, it empowers the State Board of Agriculture to promulgate, as the occasion demands, rules and regulations governing any evil or apparent evil relating to seeds, plants, insects or diseases.

The effects are now quite obvious. The wild-eyed speculator who a few years ago posed as a fruit tree dispenser of unbounded integrity, has lately either changed his vocation or his methods of speculation. The result is that the honest nurseryman now has the advantage in his favor, and the people are beginning to recognize not only

this but also the fact that the advantage lies in their favor. As a consequence, the rules governing the sale of nursery stock by agents of nursery companies have done much to strengthen the integrity of the nursery business.

The law and the rules promulgated by the State Board of Agriculture give ample power to the State Inspector of Nurseries. The entomologist of the State Experiment Station at Stillwater is by virtue of his office State Inspector of Nurseries. All nursery stock must be inspected by him or his deputy during the growing season. All nurseries desiring inspection are expected to report to the Secretary of the State Board of Agriculture at Guthrie. As a general rule, all the first class nurserymen write early in the season and state whether or not inspection is desired. This enables the inspector to arrange such an itinerary as will enable him to visit all the nurseries with the least possible expenditure of time and money. One bad feature resulting from dependence on reports is that nurserymen beginning or retiring from business almost invariably fail to communicate in time to save trouble and expense. The nurseries of this state are not the only places embraced in the inspector's sphere of action. Every farm, town or city, public park and cemetery is subject to inspection. In addition, carriers of the products under discussion and freight and express offices may be mentioned.

The expense of investigations and inspections is defrayed by the owner or owners. Until now the nurserymen have met all obligations. Under a proposed law a fund is to be appropriated by the state for carrying on all of the work coming under the nursery inspection laws. The idea is to provide an appropriation which shall remain as a permanent resource, and as it is expended be replenished each year by the person or persons benefited. For instance, if John Jones has an orchard in Oklahoma which needs the inspector's attention, necessary funds are withdrawn and the inspector proceeds with the work. If John Jones does not follow instructions the necessary labor may be performed under the authority of the inspector and the expense, if not met voluntarily, may be legally collected in the same way as a tax.

The interim may be short or long as far as the inspector is concerned because the money expended in conducting the work is not personal. In some instances trips of investigation must necessarily be made, the expense of which cannot be collected. For instance, a well substantiated report may come to the inspector, to the effect that John Jones is selling stock which has not been inspected according to law. If, after investigation, the inspector finds that such statement is false, John Jones should not be compelled to defray said expenses of inves-

tigation, and, as a consequence, the state would have to foot the bill. Expenses which might be incurred under such or similar conditions would be comparatively small and would be the only drain on the state appropriation. As a result the appropriation would practically constitute a permanent fund to be used over and over again.

The general effect of these laws for state protection is quite apparent. There is practically no weak place existing in them, since the State Board of Agriculture has the power of adjusting all requirements.

It has heretofore occurred that this office has received orders from nurserymen, after the regular inspection season, to proceed at once to their nurseries to make inspection since they desired a certificate. In many such instances they were asked to guarantee traveling expenses and payment of a per diem fee ($5).

Such examples show that the law is economical and effective. Some nurserymen who have very small nurseries (and also, too often, *small knowledge* of the business) look upon the law as unjust, since their expenses of inspection are comparatively greater than for larger nurseries. The law, of course, is not meant to curtail business, but to promote it. The so-called "nurserymen" who have no knowledge of the business should be eliminated for the benefit of the public. Their elimination has but little effect and does not particularly benefit the responsible nurserymen as is sometimes supposed.

The weight of the law does not fall entirely upon the nursery business. It is equally effective for the agriculturist. The nurseryman is wont to believe that he bears the burden alone. This is untrue. The farmer bears his proportionate share. If an injurious weed is allowed to become established, the farmer is held responsible for it, and the treatment for the same is charged to him. The same may be said of the owner of a shade tree in the city. The tree must be kept free from injurious pests and diseases as defined by our nursery laws or regulations.

The conclusion is clear and plain that the expense of freedom from obnoxious pests must be borne by the parties concerned. The law promulgating this freedom is new and its machinery is not yet in thorough working condition, but its parts are all present and perfect and the driving power is unlimited.

[The Proceedings will be continued in the next issue.—Ed.]

VALUE OF SODIUM CYANIDE FOR FUMIGATION PURPOSES

By R. S. Woglum, *Special Agent, Bureau of Entomology, U. S. Department of Agriculture*

For almost three years the United States Bureau of Entomology has been conducting in California an investigation of the use of hydrocyanic-acid gas for the fumigation of citrus trees, with the object of placing this very extensive practice on a more economical and effective basis. A preliminary report on results of one problem taken up during this investigation is given in the present paper.

With the exception of an instance noted below, cyanide of potassium has been the chemical used both in this country and abroad in generating hydrocyanic-acid gas for all fumigation purposes, including the fumigation of orchards, nursery stock, greenhouses, mills, dwellings, infested fruit, seeds, etc. There is, however, a second cyanide compound, cyanide of sodium, which is used more extensively for other general commercial purposes than the cyanide of potassium.

C. P. Lounsbury, Government Entomologist of Cape Colony, was the first to call attention in literature to sodium cyanide for fumigation, when, in 1905, after stating that the sodium compound yields more gas from a given weight than the potassium (the actual yield is between one fourth and one third greater), he stated that the former might possibly within a few years be used instead of the potassium salt. This supposition seems to have been based entirely on the consideration of the greater yield of gas of the former.

Early in the investigation it was learned that, unknown to the consumer, sodium cyanide has been used to a limited extent in California in practical orchard work for a number of years. This was a 99–100 per cent product instead of the 132[1] per cent which is the gas strength of the chemically pure sodium salt. Sodium cyanide has been sold under the name "American" cyanide, in distinction to "German" cyanide, which is the 98–99 per cent potassium salt commonly employed. The consumers have considered both brands to be potassium cyanide, the popular distinction being that one was made in America while the other was imported from Germany. Although the 99 per cent sodium cyanide contained fully as much cyanogen as the regular 98–99 per cent potassium cyanide, as well as being less expensive, yet it has had a very limited use, due to the inferior results obtained with it against the pests of citrus trees. Furthermore, extensive experi-

[1]Styled 132 per cent to indicate that 100 pounds sodium cyanide equals in gas product 132 pounds of potassium cyanide.

ments carried out by the chemists of a cyanide manufacturing firm which supplies the cyanide used in California led them to believe the sodium salt was inferior to the potassium in field work.

Under the belief that the sodium cyanide had not been given sufficiently exhaustive tests the writer ignored all this local unfavorable evidence, and, in December, 1908, outlined in detail a broad series of chemical experiments to secure reliable data with reference to this salt on the various factors which enter into hydrocyanic-acid gas generation. This outline of work was submitted to the Bureau of Chemistry of the United States Department of Agriculture for execution. Dr. C. C. McDonnell, under the direction of Dr. J. K. Haywood, Chief of the Miscellaneous Division, made a very careful and elaborate series of determinations, and, in August, 1909, the results of these were submitted to the writer in a carefully prepared manuscript and are used in part in the preparation of this preliminary report.

Results of Experiments

Proportion of Chemicals. In using a high grade cyanide of sodium it was found that a splendid generation of gas occurred when the proper proportions of chemicals were taken. The results of a large series of tests determined the proportion as follows: Three ounces (Av.) of cyanide, four ounces (liquid) sulphuric acid and six ounces (liquid) water. Reduced to its lowest units for rapid work in the field I have used 1½ ounces of acid and 2 ounces of water to each ounce of cyanide of sodium. This 1–1½–2 formula is recommended. With a pure cyanide it results in less than two per cent of gas remaining in solution in the residue. The reaction, which liberates the gas from a high grade sodium cyanide, produces exactly as perfect generation as from a high grade potassium cyanide. One might conclude from this single consideration that the sodium compound would be equally valuable in field results. It must be kept in mind, however, that these experiments were carried on under the careful methods of the laboratory and not the crude ways of the field; also that past experience with a 99–100 per cent article had shown it to produce results much inferior to those secured from the same percentage of the potassium salt.

Field Tests. In August, 1909, one and one half acres of orange trees severely infested with purple scale (*Lepidosaphes beckii*) were fumigated with a 124[1] per cent sodium cyanide, using the 1–1½–2 formula. Three strengths of gas were used, calculated from the cyano-

[1]See note on p. 85.

gen present in the sample as equivalent to 1, 1¼ and 1½ of the regular Schedule I for potassium cyanide as given in Bulletin 79, United States Bureau of Entomology. The results of these experiments show that not only is the effect on the insects as destructive as with equal strengths of potassium cyanide, but rather more so. Whereas it required a 1½ schedule of potassium cyanide for eradication, a 1¼ schedule of the sodium produced the same result. This would signify that under the crude conditions of orchard work a high grade sodium cyanide gives a better generation of gas than a high grade potassium.

For the sodium cyanide two parts of water were shown to be best in the laboratory tests, whereas in the earlier field work referred to three parts were used. The greater production of gas from two parts of water over three parts, called for in the dosage schedules for the potassium salt, is probably one of the reasons for the superior field results later obtained from the sodium salt.

Other experiments with a high grade sodium cyanide have been performed. The results of these, so far as examined, have shown the sodium to be at least equally efficient with the potassium.

Effect of Sodium Chloride on the Production of Hydrocyanic-Acid Gas. Newell in 1905 pointed out that sodium chloride, when present in the reaction producing hydrocyanic-acid gas, results in a partial decomposition of that gas. In order to ascertain more thoroughly the status of this salt, a large amount of experimental work has been carried out. These tests not only corroborated Newell's results, but also showed that if a sufficiently large percentage of sodium chloride was present the decomposition would be so great as to result in the liberation of little, if any, cyanide gas. The practical value of this consideration is that all commercial cyanides contain more or less sodium chloride. Analysis of a sample of the brand of sodium cyanide formerly used in California orchard fumigation showed it to contain 14.2 per cent sodium chloride. The amount of cyanogen present was 101 per cent. While a 97 per cent commercial potassium cyanide, containing only a trace of sodium chloride, yielded 94 per cent of its total gas, this 101 per cent sodium cyanide yielded only 63 per cent of its total, 34 per cent being decomposed, due to the presence of the chloride. Other brands of 98–100 per cent sodium cyanide submitted were shown to contain proportionately larger amounts of sodium chloride.

The presence of sodium chloride accounts for the failure of these cyanides in past fumigation work.

Conclusions

1. It has been shown above that a cyanide containing a high percentage of cyanogen is not the only consideration in determining its use for fumigation purposes. Of equal importance is that it be practically free from sodium chloride. A cyanide containing in excess of one per cent of sodium chloride should be condemned.

2. In field work, as well as in the laboratory, high grade sodium cyanide has produced exactly as satisfactory results as high grade potassium cyanide. In fact, the results from the field tests thus far examined indicate that the former, under the crude conditions prevalent in orchard fumigation, is slightly superior to the latter. A sodium cyanide of less than 123 per cent purity should never be used. Preferably the purity should be from 126 to 130 per cent. Such a high grade chemical seldom contains more than a trace of sodium chloride.

The price of the 126–130 per cent sodium product is almost the same as that of the 98–99 per cent potassium salt. The former produces at least one fourth more gas. After deducting the cost of the greater amount of acid required to liberate the gas from the sodium cyanide we still have an economy of between 10 and 20 per cent in favor of the sodium salt.

From these considerations, as well as the fact that the rapid exhaustion of the deposits of potassium carbonate, which is the source of potassium cyanide, has been causing the price of this cyanide gradually to increase, leads the writer to believe that in a few years the use of sodium cyanide for fumigation purposes will become general.

SUPERPARASITISM: AN IMPORTANT FACTOR IN THE NATURAL CONTROL OF INSECTS[1]

By W. F. Fiske

In his study of the parasites of the white marked tussock moth, the results of which were published as Bulletin No. 5 of the Technical Series, Bureau of Entomology, Dr. L. O. Howard says of the oviposition of the common parasite, *Pimpla inquisitor:*

"It happened on several occasions that the adult Pimpla was observed to oviposit in tussock-moth caterpillars which were already infested with Tachinid larvæ. Several such caterpillars were isolated

[1]Occasional contributions from the Gypsy Moth Parasite Laboratory, II.

for observation, and in every case but one there was no development to maturity of either the dipterous or the hymenopterous parasite. In one case, however, an adult of the Tachinid *Euphorocera claripennis* issued from such a caterpillar. The probabilities are that its larva was already well grown when its host was stung by the Pimpla and that the larvæ of the latter failed to find sufficient nourishment for development.

"Such instances would seem to show that the maternal instinct is not so prescient as has been supposed, and that all the preliminary investigation of the host insect by the mother parasite and all the apparently anxious soundings and tappings with her antennæ, while appearing to satisfy her that everything is all right, do not always result in the depositing of the eggs under just the proper conditions. It is altogether likely that other parasitic Hymenoptera occasionally, and perhaps frequently, make similar mistakes, and that many parasites suffer from this rivalry based upon erroneous instinct, as well as from the attacks of hyperparasites. Such mistakes are, of course, much more likely to occur during such times of extraordinary multiplication than when the species are normally abundant."

Upon other occasions, similar observations have been made and commented upon both in Europe and in America, but in no case which has come to the attention of the writer has their significance been so clearly understood as is indicated by the above quotation. It is his present opinion that such double parasitism is of much more than incidental and academic interest.

In the brief account of the parasites which had been reared from the cocoons of *Samia cecropia* and *Callosamia promethea,* which appeared in No. 6 of the second volume of the JOURNAL, something was said of the various forms of double parasitism which were encountered. A large number of other observations of a similar nature are recorded in the note files at the Gypsy Moth Parasite Laboratory, and from time to time, as opportunity permits, it is hoped and intended to publish certain among the more interesting and suggestive of these. For the present it is merely intended to propose the term *superparasitism* to designate these phenomena, to define this term, and to attempt to demonstrate the importance of the principle involved in the natural control of insects.

Definition. Superparasitism results when any individual host is attacked by two or more species of primary parasites, or by one species more than once. It differs materially from secondary parasitism, or hyperparasitism as it is variously called, although both are, strictly speaking, double parasitism of an individual. In superparasitism the

parent females are both attracted to the primary host primarily for its own sake. In hyperparasitism one of them is attracted to the primary host secondarily and incidentally, and for the sake of the primary parasite which it harbors.

It is difficult to draw a hard and fast line which shall separate all forms of double parasitism into either the one or the other. There are several instances in which it is difficult to determine which relation the parasite actually occupies. Theronia, for example, is indubitably primary on occasion, but at the same time so frequently superparasitic as to make it appear that it is attracted by the presence of the other parasite as strongly as by the primary host. It has been the cause of a great deal of perplexity in the work of parasite introduction, solely on account of this doubt as to its true nature, and it was a long time before it was definitely determined to be primary more frequently than it appeared to be secondary. It is at present considered to be a true primary parasite, but one which is in danger of becoming a true hyperparasite in the course of its further evolution.

Manifestations. The manifestations of superparasitism are exceedingly diverse, and as in the case of Theronia oftentimes puzzling to the observer. The most conspicuous is that which has been defined by Mr. W. D. Pierce in his discussion of the parasites of the cotton boll weevil[2] as "accidental secondary parasitism," a term which applies very well indeed to this form of superparasitism, but not at all to the others. Accidental secondary parasitism occurs frequently in connection with other hosts than that upon which Mr. Pierce conducted his investigations, and it is characterized by the larva of one parasite developing at the expense of another in very much the same manner as would that of a true secondary parasite under similar conditions. The only real difference is that already set forth in the definition given, that in the one case the second parasite is attracted to the primary host, and in the other to the host because it is already parasitized.

In the very great majority of instances one parasite is destroyed through the premature death of the primary host due to the attack of the other. Under such circumstances the evidences of superparasitism are only apparent through a careful dissection and microscopic examination of the host remains. The larva of the parasite which suffers destruction may or may not be devoured by the other in such instances.

Frequently both parasites die without either completing its transformations, but usually, though not always, they are stunted and weakened, and their powers of reproduction are seriously curtailed. Sev-

[2]Bull. United States Department of Agriculture, Bureau of Entomology.

eral experiments which have been planned and executed for the express purpose of determining this point have indicated in each instance that the reproductive capacity of *two* parasites which developed on a host just large enough for one, was very much less, combined, than that of one developing under otherwise identical conditions. In one instance in particular, although several times as many individuals were secured as the result of superparasitism, they were unable to reproduce at all. It is, therefore, evident that the indirect results of superparasitism may be greatly to the disadvantage of the parasite, as well as the direct results following the premature death of the host.

Classified somewhat more formally, the manifestations of superparasitism are as follows:

(I) One parasite lives; the other dies.

- (a) The survivor preys upon the other as an accidental secondary parasite. Of common occurrence.
- (b) The survivor destroys the other by bringing about premature death of the host, and may or may not devour it incidentally. Of common occurrence.

(II) Both parasites live.

- (c) Neither are the worse for the circumstances. Very rare.
- (d) One or both are so seriously weakened and stunted as to bring about a material reduction in their capacity for reproduction. Common.

(III) Neither parasite survives.

- (e) This may be brought about through premature death of the host through excessive parasitism (commonly); or,
- (f) Through inability of either parasite to complete its transformations on the limited supply of food. Common.

Instances illustrative of several of the above conditions were mentioned in the paper upon the parasites of the Saturniidæ, to which reference has already been made.

It is interesting and important, in this connection, to note that in those instances which fall in division I, the surviving parasite is not infrequently seriously dwarfed and proportionately weakened. The results, therefore, are equivalent to those obtaining in section III.

Prevalence. The prevalence of superparasitism depends entirely upon whether or not the female parasite is gifted with a prescience which will enable her to select healthy hosts for her offspring. Presupposition that she possesses this instinct is equivalent to a denial of the existence of superparasitism. This is indubitably *not* in accordance with conditions as they exist in the field and laboratory.

Total absence of any such instinct makes the prevalence of superparasitism wholly dependent upon and governed by the law of chance. If it could be shown to be the rule, a calculation of the probabilities of the occurrence of superparasitism would be a comparatively simple problem in mathematics.

In so far as those parasites are concerned which, like certain of the Tachinids and apparently of a few among the Hymenopterous parasites, deposit their eggs or young larvæ upon the food or the food plant of the host, it must be conceded that the laws of chance apply with scarcely any modification. A Tachinid, which deposits its eggs upon the foliage of trees infested by caterpillars of its favored host to be eaten by them, is trusting wholly to chance and to nothing else. The fact that the parent fly is attracted to the vicinity of the host before depositing her eggs affects the matter not at all, because no particular individual is selected or can be selected for the attack.

In the case of those which attack a selected host it is easily conceivable that a highly developed instinct might enable the parent to govern her selection, but that such is not the universal rule is as easily demonstrated. Until very recently it could have been stated without reserve that not a single parasite among the many studied at the laboratory indicated in any way the possession of such discretionary powers. At the present time the statement cannot be made thus unrestrictedly, but it can still be said of the vast majority of the species which have been the subject of more or less thorough study. In a very few species, relatively, faint indications of such prescience on the part of the parent females are apparent.

In the opinion of some, mathematics and entomology exemplify, respectively, the most exact, and one of the least exact among the sciences, and the writer is well aware of the dangers which attend any attempt to combine the two, but if, as must be conceded in some instances, and as may yet prove to be the fact in all, the prevalence of superparasitism is determined by chance alone, it is interesting to speculate a bit on what might occur under fixed conditions.

Given 100 insects, suitable as hosts, and equally attractive to a given species of parasite, inhabiting a restricted territory (call it an island), and let each of them be equally exposed to parasitic attack. Let one fertile female parasite capable of depositing several hundred eggs be given free access to her favored host under these conditions. Suppose, what is perfectly possible, that the parasite is unable to choose between hosts which are healthy and those which are already parasitized.

With the deposition of the first egg, a parasitism of 1 per cent re-

sults. The second egg, if deposited in a different caterpillar, brings about a parasitism of 2 per cent, but there is a chance that it will be deposited in the same host. The odds, to be exact, are 1 in 100, so instead of 2 per cent of parasitism, the chances are even that the parasitism is 1.99 per cent. This is, of course, impossible with only 100 hosts, but there is no other way to express the conditions.

The third egg is much more likely to be deposited in a third caterpillar than otherwise, but at the same time there is the 1 chance to 100 that was mentioned above, which must be taken into consideration, and in addition 2 chances to 100 that it will be deposited in one or the other of the two hosts previously attacked. Reduced to percentage, the chances are that instead of 3 per cent of parasitism as the result of the deposition of three eggs, it will be 2.9701 per cent.

As parasitism progresses, there is, obviously, a rapidly increasing chance that the parasite will select an already parasitized host for attack, and by the time that ten eggs are deposited there is an even chance that one among them is wasted. When a parasitism of 50 per cent has been reached, the chances are even that no less than 10 have been similarly wasted, and the chances are against instead of in favor of the selection of an unparasitized host ever after.

Instead of 100 per cent of parasitism resulting from the deposition of 100 eggs, chance favors a parasitism of about 64 per cent. In other words, out of 100 eggs 36 are likely to be deposited in hosts already attacked. If the parasite continues oviposition, it is an even chance that 77 out of the next 100 eggs will be injudiciously placed, and 92 out of the third hundred. This is a total of 205 out of 300 eggs which have been wasted. It will, in theory, require about 450 eggs to bring about 99 per cent of parasitism, and since the odds are now 100 to 1 *against* the parent selecting the last remaining unparasitized individual, more than 500 eggs in all must be deposited before 100 per cent of parasitism may reasonably be expected.

In the accompanying diagram, the vertical lines are indicative of the number of parasite eggs deposited, and the horizontal of the hosts attacked. The straight line AB, indicates the percentage of parasitism which would result were the female parasite capable of intelligent selection of her host, and the curve, AC, that which would theoretically result under conditions as above outlined.

That the calculation is not altogether fantastic is indicated by certain experiments which have been carried on in the laboratory, in which conditions not so very different from those prevailing in the imaginary island have been artificially produced. The results have not been exactly in accordance with the curve as shown, but nearly

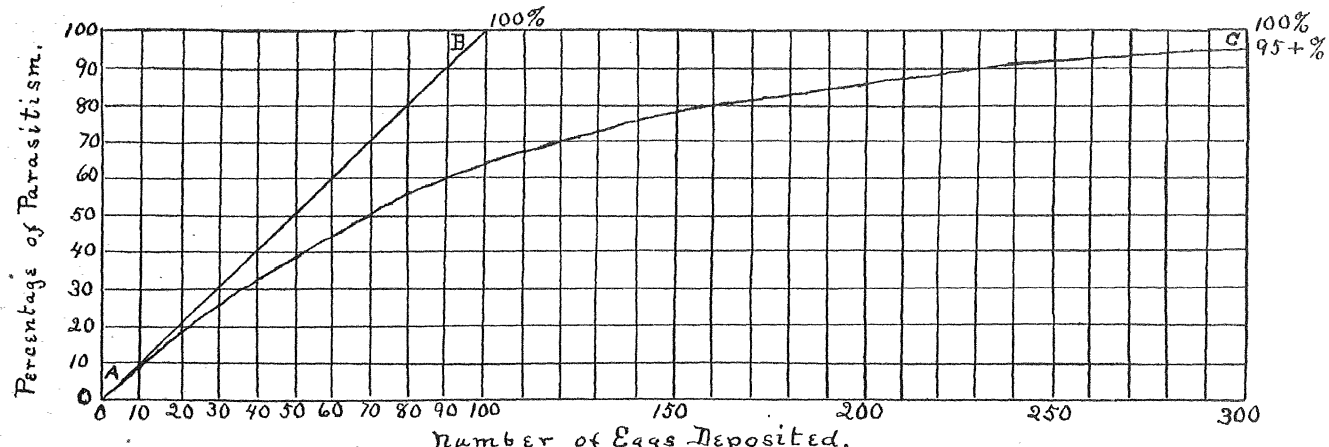


Fig. 2. Diagram showing effects of superparasitism. Line A B indicates percentage of parasitism provided the female is gifted with discretionary powers; curve A C, parasitism resulting if the female is not so gifted (original).

enough so to indicate that it has a certain basis upon fact. It is probable that the actual curve would vary under identical conditions, but with different species of parasites in accordance with the development of the maternal prescience of each, but it is probable that in every instance it would lie somewhere between the lines AB and AC, which represent the limit of variations under conditions as given.

Actually, in the field or in the laboratory, it would frequently fall outside of AC; that is to say, superparasitism would be distinctly more prevalent in proportion to the percentage of total parasitism. It is usually the case that a part of the hosts are more exposed and therefore more liable to parasite attack than the rest, and these will be attacked to the benefit of the others. Repeated instances of this sort have arisen in the course of the work.

Economic Importance. If, as seems probable, the utilization of the natural enemies of injurious insects becomes a well established method of insect control (if indeed it has not already become so), every phase of insect parasitism takes on economic importance proportionately. Superparasitism is undoubtedly the equal of hyperparasitism in its effect upon the natural control of parasitic insects, and should be given equal attention. Only upon very rare occasions, as shown in the table of its manifestations, does it permit both of the parasites involved to reach full maturity. In the minority of occasions only one of them does so, and in the majority both are seriously affected, if not destroyed outright.

As stated above, its actual prevalence is apt to be greater than indicated in the diagram, and has been greater in certain work which has been carried on at the Melrose Highlands laboratory. In the course of this work three genera of parasites have been brought under successful laboratory control, and their propagation undertaken as an economic enterprise. In every instance superparasitism has resulted to an extent comparable to that indicated by the table, *counting only those hosts which are equally exposed* to attack by the parasite, and leaving out of consideration those which were partially protected. In the instance of two of the parasites, superparasitism resulted in the production of dwarfed and worthless individuals, which proved to be of little, and in one instance of no, value for continued reproduction. In the instance of the third parasite, superparasitism resulted in the death of all but one of the individuals attacking an individual host, and the survivor emerged apparently none the worse for its prioristic combats. In this case the outcome was nothing worse than a reduction in the rate of multiplication; in the others there was a serious additional loss due to the degeneration of the survivors, which was not

offset by their larger numbers. Similar conditions may be expected to prevail in the field.

More than 50 per cent of parasitism by species which attack the pupæ of any lepidopterous insect is rare, or appears to be so, and has never been encountered in the experience of the writer. A higher rate of mortality frequently results when the pupa of the host is also affected by parasites which have attacked it during its larval stages, as for example in the case of the tussock moth which dies after constructing its cocoons through parasitism by Tachinids, as well as by Pimpla and Chalcis. If the parasitism by Tachina amounts to 50 per cent and of Pimpla and Chalcis together to 50 per cent, it is safe to say that 25 per cent of the host will escape attack entirely, and that a considerable majority of the parasites, taken altogether, will be involved in a conflict between themselves. This conflict, as already stated, may result variously, but with rare exceptions to the disadvantage of one or both of the participants.

It is very largely on this account that it is deemed inexpedient to depend upon the parasites, which confine their attack to any one stage of the host, to effect the control of an insect like the gypsy moth, which is subject to the attack of several distinct groups of parasites at different stages in its career. It is recognized that the parasites have their own enemies to contend with, and that they are subject to all of the other and various controlling influences which go to maintain the stability of the natural balance. Add to these the losses which they would suffer through undue superparasitism, and the chances for their continued increase to the point where they could be expected to exert effective control of an insect so fecund as the gypsy moth are greatly reduced.

The importance of superparasitism, in its relations to hyperparasitism, is also considerable. It is probable, in the last analysis, that true *tertiary* parasitism will be found to be of rare occurrence, and that instances in which a secondary parasite is attacked are, for the most part, examples of superparasitism pure and simple. The destruction of host by parasite, and parasite by hyperparasite may be, and frequently is, carried beyond "quarternary" and "quinquenary" parasitism, but in relatively very few instances are the species involved incapable of attacking the original parasite as well as its secondaries.

The general subject of parasitism, as a factor in the natural control of insects, is of course the main, and almost the only subject under consideration at the laboratory. Its phases are manifold and varied in the extreme, but there is hardly a single one which is not involved more or less directly with some phase of the subordinate topic of super-

parasitism. In any discussion of the progress of the general project, or of any of its ramifications, superparasitism will enter and must be considered. On this account, the writer begs the indulgence of entomologists for the introduction of a new term into an already overburdened vocabulary.

AMARA AVIDA SAY AS A STRAWBERRY PEST

By John B. Smith, Sc. D.

That certain of the *Carabidæ* will, under some conditions, vary their normal predatory habits by feeding in the adult stage upon vegetable matter is well known, and almost every collector has seen some of the species of *Harpalus* in late summer feeding upon the seeds of grasses and rag-weed. In Europe *Zabrus* is known to have similar habits and to appear in some cases as a genuine pest.

Just why these occasional general resorts to plant food occur has never been satisfactorily explained, for several years in succession may go by without any appearance of the insects on seeds, and then, for a year or two, they will be noticed in many localities.

In 1900 two species of *Harpalus*, *caliginosus and pennsylvanicus*, were found in Pennsylvania and Ohio, injuring strawberries, just ripening, in June, by eating out the seeds, and in the process so mutilating the flesh that the berries became unsalable. Webster in Ohio and Slingerland in New York reported these outbreaks, and described the work of the insects and their habits very carefully. But there seems to be no explanation for the sudden increase so early in the season, and the occasion for the resort to the strawberries.

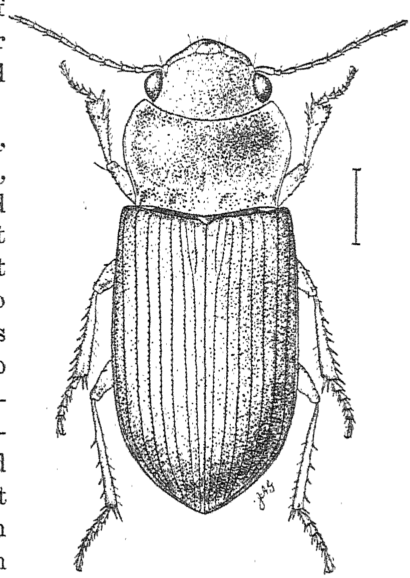


Fig. 3, Amara avida Say (Original).

During the early days of June, 1909, I made a trip through the strawberry region of Cumberland County, New Jersey, and was advised, as I approached the Maurice River, of a new "bug" that ate into the ripening strawberries and destroyed the entire crop. No one had ever seen its like before, and the descriptions left me wholly at sea concerning its identity. The statement that they ate each other

up when a lot of them were put together suggested Carabids; but the size, color and active diurnal habits of the species seemed to negative this, and it was not until I actually saw the specimens that I recognized the depredator as *Amara avida* Say. The insects had been only recently matured, many of them were not yet fully colored and some of them had the chitin not yet fully hardened. This gave the majority a lighter, more brownish bronze color than normal, and had helped to lead me astray, since everybody referred to them as brown in color.

The insects were present in great numbers on a comparatively small area of young beds, and practically every berry was destroyed. Fortunately, it was the first year out, and the crop was small; but the owners feared for the future. This particular species is not one of the more common ground beetles and, so far as I am aware, has never been accused of doing similar injury; so I was interested to discover, if possible, the reason for the invasion.

The Maurice River is a deep, navigable stream for several miles from its mouth, but has low and very flat banks for a considerable part of its course, and these are overflowed much of the time, forming under natural conditions a deep morass. Some of the owners along the river combined and organized to dyke out for some miles along the course, and thus several hundred acres of very rich land were made available. The land after being dyked was left water covered for a year or two and then drained. To dry out, it was left another year or two untouched and allowed to grow up into reeds, rushes, grasses and in fact whatever would come in naturally. The result was a dense mass of luxuriant vegetation that afforded excellent feeding ground for numerous insect species, and also for their natural enemies—ground beetles among them.

In the summer of 1908 part of this land was plowed and cultivated and later set out in strawberries. In the spring of 1909 other adjacent land was plowed, and left to be cultivated and prepared for planting later. It was in this mass of plants just turned over that this large lot of *Amara* species matured in late May, and they found themselves entirely without normal insect food, and, at that season, no seeds nor other attractive plant food on the area on which they had been born. But close at hand was the small crop of strawberries on the late set plants of the previous year, and these fell victims to their hunger. Feeding was done chiefly at night, but the beetles could be readily found under the plants during the day, and they ran actively and flew readily.

I advised that the turning under of the drained area be completed as rapidly as possible, and that no new section be plowed under just before a strawberry season, so as to avoid forcing the beetles from their natural feeding grounds just when the berries were most susceptible.

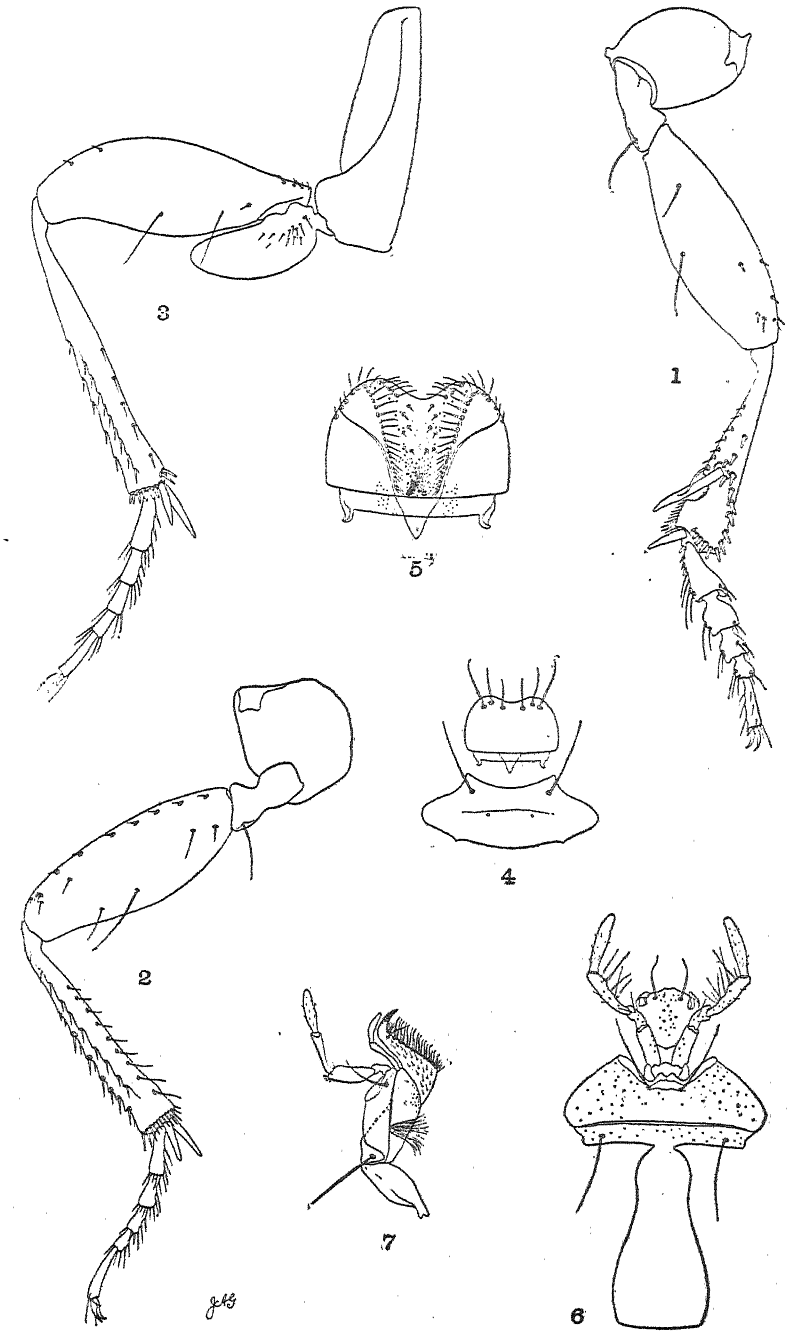


Fig. 4. Amara avida Say. Structural details: 1, anterior leg; 2, median leg; 3, posterior leg; 4, clypeus and labrum from above, showing setæ; 5, epipharynx; 6, labium from beneath, including gula; 7, maxilla.

BLATTID NOTES

By Arthur H. Rosenfeld, *Baton Rouge*.

Eggs of *Periplaneta americana* L.

At various times during 1908, examinations were made of oötheca of the American cockroach, to determine the average number of eggs in these pouches. The results of ten examinations are as follows:

Date of Examination.	Number Eggs in Oötheca.
July 4	10.
August 1	24.
September 4	28.
September 7	18.
September 21	24.
September 21	28.
September 21	28.
September 21	26.
September 21	28.
September 21	26.
Average of 10 oötheca	24.

Eating of Eggs

On August 10, 1908, in a cage containing eleven *P. americana* L., one female was observed carrying a large oötheca. The following morning it was found that the egg-case had been destroyed, nothing but portions of the outer shell remaining. The cockroaches were supplied with an abundance of food, hence the eating of these eggs was not caused by starvation.

Do Roaches Cause Fires?

At the suggestion of Mr. Wilmon Newell, adults of *P. americana* and *Blatella germanica* Linn., were placed in straight-walled glass vessels with parlor matches, in order to determine the possibility, or probability, of these insects setting fire to houses by igniting matches. Fire in houses have several times been thought to have originated through cockroaches or mice igniting matches by gnawing upon them. No food was supplied the insects in these tests.

Two *Periplaneta,* placed in a Mason fruit-jar June 29, 1908, were dead July 8th. Matches not ignited.

Two *Blatella germanica,* placed in Mason fruit-jar with a few par-

lor matches July 1, 1908, were still alive August 15th. Matches not ignited.

Length of Life

A large specimen of *P. americana* was placed in a breeding cage June 26, 1908, and kept constantly supplied with food in the shape of Irish potato, starch, etc. This cockroach lived until October 30, 1909, or a period of 1 1-3 years.

THE SAN JOSE SCALE AND ITS RELATION TO CLIMATIC DISTRICTS OR LIFE ZONES IN WISCONSIN

By Henry H. P. Severin, *University of Wisconsin.*

A number of economic entomologists have put the question to me, "Is Wisconsin free from the San José scale?" Marlatt[3] writes, "Wisconsin is, on the authority of Mr. E. P. Sandsten, horticulturist of the state experiment station, now free from the San José scale. The only occurrence of this pest in the state was three years ago in the extreme southern part, and it was here stamped out by the prompt adoption of radical measures." The people of Wisconsin ought to congratulate themselves if such a condition actually exists. From what work my brother and I have done in preparing our paper, "A Preliminary List of the Coccidæ of Wisconsin"[4] (the species mentioned were, with one exception, collected in or near Milwaukee), and from the few days I have spent in the field in or near Madison I am thoroughly convinced that the people of this state would be surprised at the results of a systematic inspection in regard to this pest.

The relation of climate to the spread of the San José scale has been considered by Howard and Marlatt in three bulletins.[1 2 3]

Dr. C. Hart Merriam has established a number of climatic districts or life zones within which particular animals or plants perpetuate themselves and outside of which they fail to become established. These life zones are: The tropical, occupying small areas in Florida and southern Texas; the lower and upper austral, covering the bulk of the United States; the transition zone, coming between the last and the boreal zone of Canada northward. "The early records led to the belief that the San José scale would be practically limited to the upper and lower austral zones, and that the important fruit districts in the

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[1] Bull. No. 3, U. S. Dept. of Agric. Bureau of Ent., 1896.
[2] Bull. No. 12, U. S. Dept. of Agric. Bureau of Ent., 1898.
[3] Bull. No. 62, U. S. Dept. of Agric. Bureau of Ent., 1906.
[4] Journ. of Econ. Ent. II, No. 4, 1909, pp. 296–298.

northern United States and in the elevated mountain regions, represented by the transition zone, would be slightly, if any, infested. In the main, the records of the distribution of the San José scale have confirmed this belief. Nevertheless, the scale has, in a number of instances, appeared well into the transition zone as fixed by Doctor Merriam, notably in Massachusetts, in New York, in Michigan and a few other points; but in most of these cases the evidence gained from the relation of other animals and plants would indicate that the transition and upper austral zones were not correctly charted, so that in general the belief in the immunity of the transition zone holds."

A comparison of the maps in bulletins 3 and 62, p. 34, shows that the life zones have also been corrected in Wisconsin. According to the former map all that part of Wisconsin south of a line drawn more or less obliquely across the state, from the neighborhood of Milwaukee on the east to near the middle of the state on the west, belongs to the upper austral zone, whereas in the later corrected map only the southwest and southeast corners of the state belong to this zone. The

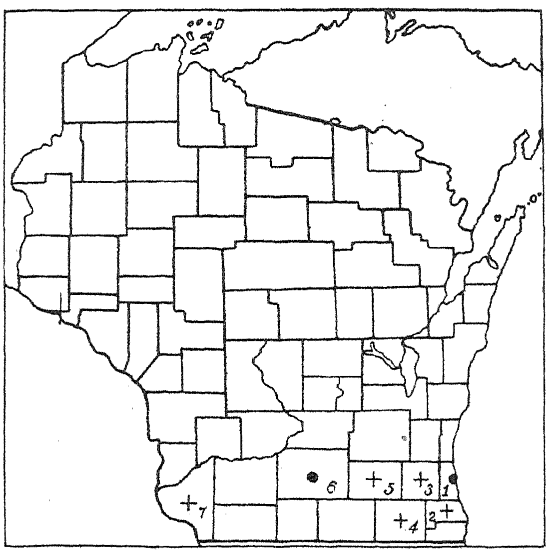


Fig 5, Map Showing Counties in Which the San José Scale Has Been Found; 1 Milwaukee, 2 Racine, 3 Waukesha, 4 Walworth, 5 Jefferson, 6 Dane, 7 Grant.

following map showing the counties in which the San José scale has been found in Wisconsin, indicates that this pest is confined to the southern part of the state. The counties designated by a plus sign are given on the authority of Prof. J. G. Moore, the former nursery

inspector; the heavy, black dots show the localities in which my brother and I have found this pest.

From the present data on the distribution of the San José scale in Wisconsin, it is apparent that it has not been found in the transition zone as limited by the earlier map; however, according to the later corrected map, the pest has established itself within this zone. As Marlatt[3] writes, "too much stress, however, should not be put on zonal limitations, and there may always be outbreaks of longer or shorter standing in the borders of the transition region."

While collecting insects in the vicinity of Madison no attention was at first paid to ascertaining the presence of scale insects, but while working at Tenny Park, which is located about three or four miles northeast of the State Experiment Station, my attention was drawn to a very serious infestation of the Willow scale, *Chionaspis salicis-nigræ* (Walsh).* It occurred most abundantly on two species of dog-wood; the red dog-wood, *Cornus stolonifera,* and the gray dog-wood, *Cornus paniculata.* So serious was the infestation that on many of the red dog-wood shrubs not a bit of red bark was visible, the twigs and branches being plastered from the very tips of the twigs to the roots with this conspicuous white scale. On the red dog-wood these were accompanied by a very serious infestation of the San José scale, causing the shrubs to appear as if covered by soot from the nearby factories and railroads, leaving only here and there small patches of red bark on the branches. In Vilas Park and in a cemetery, both within two miles of the State Experiment Station, the San José scale was again found upon recently planted shrubs.

A twig of this material, which was collected in Tenny Park, was sent to Mr. J. G. Sanders, agent and expert at the Bureau of Entomology, Washington, D. C., in order to have him verify my identification. In a letter he writes: "Your letter of November 7, and accompanying specimen of scale at hand. You were correct in your determination of this scale insect as the genuine San José (*Aspidiotus perniciosus* Comst.). The twig which you sent was very seriously infected, indicating that this particular tree had been infested for at least two or three years."

* Prof. Wm. S. Marshall has pointed out to me, along the University Drive in Madison, this same scale insect, which has become so injuriously abundant on the American Aspen or Quaking Asp (*Populus tremuloides*) as to kill some of the trees.

Scientific Notes

Gypsy Moth at Wallingford, Conn.—A serious infestation of the gypsy moth was discovered at Wallingford, Connecticut, about twelve miles north of New Haven, during December. Up to the time of this writing nearly 6,000 egg-masses had been found and destroyed by soaking them with creosote oil. The center of the infestation is in the village, and while the limits have not yet been determined it is hoped that the pest has not spread to the surrounding country.

The suppression work will be conducted vigorously under the supervision of the State Entomologist, and if possible the pest will be exterminated from this locality, which is the farthest point westward where this insect is known to occur.

Heretofore the only known infested locality in Connecticut was Stonington, where, after four seasons' work, the pest has been nearly exterminated.

W. E. B.

Carbon Tetrachloride vs. Carbon Bi-sulphide.—Several serious disadvantages attend the use of carbon bi-sulphide as a fumigant when used in buildings for the control of pests of grain products or natural history collections, particularly its inflammable character, disgusting and irritating odor, and diagreeable residuum. Last year I experimented with the tetrachloride of carbon, using larvæ of Attagenus as subjects, and found it much more agreeable to use and reasonably effective. On my recommendation several others have tried it with satisfactory results.

In tight cases it should be used at a strength of 45 to 50 cc. per cubic foot. For the standard museum case, 16 x 19 x 3 inches, 15 to 20 cc. is sufficient if the case shuts tightly. For large cases a strength of one quart to 50 cubic feet is desirable—practically twice that of carbon bi-sulphide, of which a pint to 50 cubic feet is sufficient.[1]

Carbon tetrachloride is a clear, volatile, heavy liquid with a specific gravity of about 1.6. It is non-inflammable, and its odor on evaporation is scarcely noticed where that of bi-sulphide would be intensely disagreeable. It is very useful as a solvent of oils, rubber, etc., agreeably replacing gasoline or naphtha for removing grease from clothing or insect specimens without injury to color. ("Carbon," etc.) When purchased at retail the price ranges about 30 or 40 cents per pound, but in quantity it may be had for about one third as much.

Albert P. Morse, *Wellesley, Mass.*

[1] I am aware that this amount of carbon bisulphide is much greater than is generally stated to be necessary, but a strength of one pound to 1,000 cubic feet of space has not proved satisfactory for museum pests, the above proportions being found necessary in the experiments referred to above.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1910

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints may be obtained at cost. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—EDS.

The recent Boston meeting must rank, as Boston meetings universally have ranked in the past, as one of the most profitable scientific gatherings. There was a large attendance of entomologists from the northeastern United States in particular. It is to be regretted that so few Washington (D. C.) entomologists were able to be present. Their absence was a distinct loss not only to those in attendance but also in a measure, at least, to themselves. The most satisfactory progress is possible only when investigations and plans for future work are discussed in thoroughly representative assemblies. Aside from all questions of friendship, good fellowship, etc., it is distinctly unfortunate that our progressive Bureau of Entomology was not more adequately represented at the various sessions. The practice of submitting abstracts of the longer papers, leaving the details for publication, appears to be growing and certainly afforded a most welcome relief from the pressure of earlier meetings and thus permitted extremely desirable discussion. Friendly and courteous criticism of results obtained and discussion of methods employed in investigations cannot but result in good to all. There was a large series of very meritorious papers, several of them being concerned with methods, which latter, it should be remembered, eventually determine the reliability of our results. There have been discussions in the past as to the standardization of methods and more attention can well be given to this subject in the future.

The following statement of business manager shows a most gratifying condition of affairs: The year 1909 closed with 542 subscribers, an increase of 57 over the previous year, and with a balance of practically $250. The total income for the year was $1,448.14, with bills receivable of $263.76 and a balance from 1908 of $191.36, making a total income of $1,903.26. The total expenditures were $1,230.93, of

which $1,090.05 was for printing. There are bills payable of $353.10, $268.40 for No. 6 of Vol. II, making the total expense for the year $1,584.03. The publication of the JOURNAL would be very difficult were it not for the generous support of our advertisers. From the tone of letters from our advertisers in renewing their contracts, practically all of which have been renewed, we are led to believe that our readers appreciate the advertisers of the journal and that they are receiving most satisfactory returns from the JOURNAL as a medium of publicity.

The JOURNAL has 140 complete volumes of Vol. I and 500 of Vol. 2. According to the vote of the company in December, 1908, the price of Vol. 1 will be advanced as soon as the stock has been reduced to 100 copies, so that any institutions or libraries wishing complete sets will profit by securing them at once.

Bills for Volume 3 will be mailed to all 1909 subscribers and we shall assume that subscribers wish the JOURNAL continued unless informed to the contrary. If remittances for Vol. 3 or orders for its continuance have not been received by April 1 the subscriber's name will be dropped from the mailing list as required by the orders of the post office department. A prompt remittance will therefore greatly aid the manager and avoid unnecessary inconvenience.

It is our hope to increase our subscription list to over 600 this year, and sample copies will be gladly sent to any interested.

We commend to the thoughtful consideration of our colleagues, a paper in this issue on one phase of parasitism. It illustrates in an admirable manner the complex character of the factors determining the ability of one organism or group of organisms to successfully control injurious species, and emphasizes the necessity of scientific investigation preceding in large measure at least, attempts at practical application. American entomologists now have an opportunity of studying the progress of one of the greatest experiments in the employment of parasitic insects. The scientific portion of this undertaking in New England has already resulted in material additions to our knowledge of parasitic and predaceous forms, while the practical results are most encouraging. Studies of various phases of the natural control of insect pests are being made by entomologists here and there throughout the country and must eventually result in the accumulation of data indispensable to those attempting to make practical use of such agents. With such knowledge as a basis, it may even be possible to discover or develop forms or races with a superior efficiency.

Reviews

The Insect and Other Allied Pests of Orchard, Bush and Hothouse Fruits, by Fred V. Theobald. Published by the author, Wye Court, Wye, England, p. I–XVI, 1–550; 326 text figures. 1909.

The author, in bringing together and summarizing the available knowledge respecting British pests, has produced a volume which should be extremely serviceable to American entomologists as well as of great value to English readers. Spraying is considered as of relatively small importance in controlling insect pests, a position quite contrary to American experience, though possibly justified by English conditions. After a brief survey of the characteristics of the various groups of the animal kingdom, summary accounts accompanied by brief bibliographies in many instances, are given of the injurious species. These latter are grouped under their important food plants, those affecting the apple occupying a considerable portion of the volume. The author precedes his discussion by a list of the species treated, the forms being grouped systematically and the character of the injury briefly indicated. American entomologists will be particularly interested in the discussion of the brown-tail moth, the codling moth, the pear midge and other insect pests common to the two countries. It will be noted that the English estimate, so far as injury is concerned, may be very different from the American status. There are many species noticed, some of which are likely to be imported on nursery stock. It might be well if the attempt of Americans to secure uniform common names for injurious insects could be broadened to include, so far as possible, the destructive European pests. The appendix discusses several extra limital species which might become destructive in England, especially the Mediterranean fruit-fly, the cherry fruit-fly, the West Indian scale, the San José scale, and gives the formulæ for various insecticides. The book is printed on a heavy coated paper, and, as a consequence, the numerous illustrations, a number American and many original, come out remarkably well. This volume should be in the hands of every economic entomologist, especially those having charge of nursery inspection work.

Spraying Apples for Curculio and Codling Moth, by E. P. Taylor, Mo. St. Fruit Exp't. Sta. Bul. 21, p. 1–69, 1909.

This bulletin summarizes an extensive series of observations and experiments upon these two important pests. The author finds that three early sprays, one when the petals are off, the second ten days later and the third ten days thereafter, resulted in 97.6 per cent of picked apples free from Curculio marks, while 45.5 per cent were damaged on the trees unsprayed. This treatment gave 99.83 per cent of picked apples free from codling moth injury, while unsprayed trees had 14.5 per cent of the picked fruit wormy. Combining the results, three sprays gave 97.4 per cent picked apples free from both kinds of injuries, while unsprayed trees had only 46.1 free from such blemishes. Furthermore, this treatment, by preventing windfalls, gave 45 per cent more picked apples than the unsprayed trees and doubled the cash returns from the crop, giving a net profit, due to the application of the poisons, of $65.36 per acre. Comparisons between applications of Paris green

and arsenate of lead gave a decided superiority for the latter. The author properly emphasizes the necessity of very thorough application if satisfactory results are to be secured. This bulletin is well illustrated and printed on excellent paper.

Insect Enemies of Tobacco, by Z. T. METCALF, N. C. Dep't. Agric. Special Bul. p. 1–72, 1909.

This publication discusses first the general forms of injury, the methods of control and the insecticides available for use. The author concludes from various estimates that there is no danger to the users of the product from applying arsenates to tobacco, though he does not advise such treatment shortly before harvesting. There is a brief discussion of insect structure and classification. Numerous forms are treated in a summary manner, the author making the bulletin of greater practical value by distinguishing between the principal and the lesser insect enemies. The publication is profusely illustrated, the appearance of many figures, however, being seriously marred by the poor quality of the paper.

Fumigation of Apples for the San Jose Scale, by A. L. QUAINTANCE, U. S. Dep't. Agric., Bur. Ent. Bul. 84, p. 1–43, 1909.

This bulletin gives in detail methods employed and results secured in fumigating fruit infested with San José scale. The author has demonstrated the practicability of such treatment and suggests the desirability of its adoption in case the countries now prohibiting the importation of fruit infested by San José scale will accept such fruit. He also calls attention to the applicability of this treatment to other fruits. The bulletin is illustrated by two admirably colored plates, and is made more valuable by an appendix giving a synopsis of the laws and decrees relating to the introduction of live plants and fresh fruits in force in foreign countries, and similar laws and regulations of the various American states.

Bee Keeping in Massachusetts, by BURTON N. GATES, U. S. Dep't. Agric., Bur. Ent. Bul. 75, Part 7, p. 81–109, 1909.

This very readable publication gives a historical sketch of bee keeping in Massachusetts, together with a large amount of interesting local information. There is an annotated list of the more important honey-producing plants, together with local observations on the nectar-producing period in representative regions. Data is given upon the employment of bees in greenhouses. One of the curious results of the investigation is the evidence gathered showing serious injury here and there to the bee keeping industry by the superabundance of gypsy and brown-tail moth caterpillars. This bulletin should be most serviceable to all bee keepers in New England, particularly as it gives a bibliography of the more important articles relating to bee keeping in Massachusetts.

Concentrated Lime-Sulfur: Its Properties, Preparation and Use, by J. P. STEWART, Pa. St. Coll. Agric. Exp't. Sta. Bul. 92, p. 1–20, 1909.

This bulletin gives in condensed form the results of extended experiments in the preparation and application of lime-sulfur washes. The author finds

that a concentrated wash about 27 degrees Beaume (1.23 specific gravity) does not freeze above 15 degrees Fahrenheit. Results of a series of trials to determine the relative amounts of lime and sulfur show that the waste is smallest when 100 pounds of lime and 195 pounds of sulfur are used to 100 gallons of water. This, it may be noted, is very nearly the same as the Cordley formula. The field results of several investigators with this wash against San José scale and apple scab are summarized. A table has been prepared showing the approximate strengths to be employed for various sprays. Experiments in the use of poisons with a lime-sulfur wash leads the author to advise the employment of arsenite of lime. This bulletin gives valuable data upon an important subject.

Current Notes

Conducted by the Associate Editor

Dr. L. O. Howard has approved plans for a special investigation of the ticks concerned in the transmission of the so-called spotted fever of human beings in the Rocky Mountain region. The coöperation of Prof. R. A. Cooley, who has done notable work on the ticks of Montana, has been obtained. He will become a collaborator of the bureau on March 1, and supervise the work done in Montana. An agent of the bureau will be stationed in the Bitter Root Valley, where a particularly virulent strain of the disease occurs, for studies of the tick throughout the season. The biological survey of the department of agriculture has agreed to place a man in the valley to obtain data on the exact limitations in the distribution of the various animals that serve as hosts for the ticks. This investigation is connected with the other tick work of the Bureau of Entomology, under the direction of Mr. W. D. Hunter.

Plans have been perfected for a coöperative investigation by the Bureau of Entomology and Clemson College of South Carolina of the cotton red spider (*Tetranychus gloveri*) in that state. A joint agent will be placed in the field on February 1.

Mr. D. L. Van Dine, engaged in investigations of the sugar cane and rice insects in the Bureau of Entomology, is about to locate at Audubon Park, New Orleans. Plans have been perfected for coöperation with the Sugar Experiment Station of the state of Louisiana. Mr. Van Dine will locate in quarters furnished by the station. His laboratory will be opened about February 1. Mr. T. C. Barber, who is engaged in the study of the relation between the Argentine ant and the sugar cane Pseudococcus, under the direction of Mr. Wilmon Newell, will be located with Mr. Van Dine.

Since the Division of Insects has been moved into the new National Museum building, the additional space has given enough room so that the entire systematic collections amassed by the Forest Insect Investigations have been moved into that building.

J. F. Zimmer, who has been working on citrus fruit insects in the Bureau of Entomology, has been transferred to the branch of deciduous fruit insect investigations.

Reginald Wooldridge has been appointed as an agent and expert for work

in the Gypsy Moth Parasite Laboratory of the Bureau of Entomology at Melrose Highlands, Mass.

Mr. M. M. High, working in the branch of truck-crop and stored-product insect investigations at Starkville, Miss., has been ordered to Brownsville, Texas, to continue the same line of work in that vicinity.

Mr. H. M. Russell, who works in the same branch formerly located in southern Florida, with headquarters at Orlando and Miami, is now located at Compton, Cal., in the special study of insects injurious to sugar beets and other vegetable crops.

Mr. W. B. Parker, University of California, Berkeley, Cal., was recently appointed collaborator in the same branch.

Mr. R. E. Snodgrass completed his work in the Bureau of Entomology on the anatomy of the honey bee in September, and left for a short trip through England and Scotland. He has now returned and is engaged in the work on the prevention of the spread of moths.

Dr. G. F. White, expert in bacteriology of bee diseases in the Bureau of Entomology, is spending the winter in Germany, taking courses in pathology in the University of Freiburg.

Mr. A. H. McCray, of the Bureau of Entomology, is on furlough for the college year. He is attending Ohio State University.

Prof. Herbert Osborn, of Ohio State University, who was granted a year's leave of absence from his university last June, is engaged in investigating the economic importance of the Jassidæ, with reference to the production of cereal and forage crops. Professor Osborn has been carrying on his investigations in the field throughout the northern part of the country during the past summer and will continue his work in the South and Southwest during the coming spring and summer, embodying the results in a comprehensive report to be published later by the Bureau of Entomology.

W. C. O'Kane, A. M., a graduate of Ohio State University, has been appointed instructor in entomology at the New Hampshire College of Agriculture and the Mechanic Arts at Durham, N. H.

The Cambridge Entomological Club gave a smoker in Copley Hall Tuesday evening, December 29, to which were invited all entomologists and geologists attending the scientific meetings.

Dr. E. P. Felt, state entomologist of New York and editor of this Journal, visited several European museums during November and December for the purpose of studying special collections.

Prof. John B. Smith gave the annual address before the Entomological Society of America at the Boston meeting Thursday evening, December 30. His subject was "Insects and Entomologists; Their Relation to the Country at Large." The address was illustrated with lantern slides, and was open to the public.

Mr. Theodore D. Urbahns, formerly of the Bureau of Entomology, U. S. Department of Agriculture, has been appointed assistant in research field

work in the Department of Entomology of the Minnesota Agricultural Experiment Station.

Mr. Arthur H. Rosenfeld, formerly assistant entomologist on the staff of the State Crop Pest Commission of Louisiana at Baton Rouge, has been appointed entomologist of the Estacion Experimental Industrial Agricola at Tucuman, Argentina, and has entered upon his new duties.

Prof. F. L. Washburn of the University of Minnesota and of the Minnesota Agricultural Experiment Station, has been granted a two months' leave of absence by the board of regents, and will spend February and March studying conditions governing the control of insects affecting market gardens and small land holdings in Europe.

According to the Experiment Station Record, Prof. John F. Nicholson, formerly entomologist and botanist of the Oklahoma College and station, has been appointed bacteriologist at the Idaho College and station and has entered upon his duties.

At the Oregon College and Experiment Station Mrs. Laura Hill Griffin has resigned as assistant entomologist and Miss Alice L. Edwards has been appointed in her place. Miss Edwards is a graduate of the college in the class of 1906.

A department of economic entomology has been organized at the University of Wisconsin, and Mr. J. G. Sanders, formerly of the Bureau of Entomology at Washington, has been placed in charge, with the rank of assistant professor. Mr. Sanders will also be state entomologist, and will have charge of nursery inspection. He will assume the duties of his new position about February 1.

In August, 1909, the Connecticut Legislature just before adjournment passed a law providing for the inspection of apiaries of the state and placing the work under the direction of the state entomologist. The appropriation is small, being only $500 for the biennial period. Two experienced beekeepers have been appointed as inspectors, Mr. H. W. Coley of Westport for the southern portion of the state, including Fairfield, New Haven, Middlesex and New London counties, and Mr. A. W. Yates of Hartford for the northern portion, Litchfield, Hartford, Tolland and Windham counties.

Mr. H. L. Frost of Arlington, Mass., has been appointed a trustee of the Massachusetts Agricultural College at Amherst. The appointment was made by Governor Draper and the term of office is for seven years, beginning January 5, 1910. Mr. Frost is a graduate of the college, is a member of the American Association of Economic Entomologists, and is the head of the well-known business firm of H. L. Frost and Company, foresters and entomologists.

Prof. Wilmon Newell, secretary and entomologist of the Louisiana State Crop Pest Commission and entomologist of the Agricultural Experiment Station at Baton Rouge, has resigned to accept the position of state entomologist and entomologist of the experiment station of Texas. He will devote his entire time to investigation and research work along economic lines,

since he is not connected with the college. His address, after January 31, 1910, will be College Station, Texas.

On Friday, December 31, 1909, a tablet was unveiled at Milton, Mass., on the house where Dr. T. W. Harris formerly lived. The tablet is of white marble, to harmonize with another tablet on the same house, which commemorates the meeting at which the Suffolk Resolves were adopted prior to the Revolution. It bears the following inscription, written by Col. T. W. Higginson, who was a pupil of Doctor Harris:

IN THIS HOUSE FROM 1824 TO 1831 DWELT
THADDEUS WILLIAM HARRIS M. D.
BOTANIST, ENTOMOLOGIST; AND FINALLY
LIBRARIAN OF HARVARD COLLEGE

IN EACH CAPACITY HE WON
FOR HIMSELF FAME AND GRATITUDE

HE HAD THE MODESTY AND UNSELFISHNESS
OF TRUE SCIENCE
WITH WHAT MAY RIGHTLY BE CALLED
ITS CHIVALRY OF SPIRIT

At the unveiling the American Association of Economic Entomologists, the Entomological Society of America and the American Entomological Society were represented by William M. Wheeler, professor of economic entomology in Harvard University; the Boston Society of Natural History, by its curator, Mr. Charles W. Johnson; the Cambridge Entomological Club, by Mr. H. H. Newcomb; the Milton Historical Society, by Dr. W. W. Newcomb of Detroit, Mich., and Mr. W. L. W. Field of Milton, Mass.; the Science Club of Milton Academy, of which Doctor Harris was a trustee, was also represented.

According to the Experiment Station Record, "the *London Times* announces the appointment by Lord Crewe of a scientific committee of twenty, to be known as the African Entomological Research Committee, the object of which will be to further the study of economic entomology, with special reference to Africa. Lord Cromer has consented to act as chairman and Guy A. K. Marshall as scientific secretary.

"Arrangements are being made to send trained entomologists to the east and west sides of tropical Africa, respectively, to stimulate interest in entomological work among the officers and other residents of the regions, and to afford instruction in the use of scientific methods. It is hoped thereby to obtain an organized body of investigators. The committee will also keep in touch with work already under way, and has received offers of coöperation from the British Museum, the London and Liverpool Schools of Tropical Medicine, and the leading English universities. It is planned to publish observations and scientific results in a journal or series of bulletins to be established."

Mailed February 15, 1910.

JOURNAL

OF

ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 3 APRIL, 1910 No. 2

Proceedings of the Twenty-Second Annual Meeting of the American Association of Economic Entomologists

(Continued from the February issue)

Morning Session, Wednesday, December 29, 1909

The meeting was called to order by President Britton at 10.15 a. m.

PRESIDENT BRITTON: The first paper to be presented is by Mr. E. D. Sanderson, Durham, N. H., on "The Relation of Temperature to the Growth of Insects."

THE RELATION OF TEMPERATURE TO THE GROWTH OF INSECTS

By E. DWIGHT SANDERSON, *Durham, N. H.*

At the Chicago meeting of this association in 1907 the writer showed (24a) that upon purely theoretical grounds there could be no uniform accumulation of temperature or "thermal constant" for the various stages of insect growth, but that the relation of temperature to growth phenomena was probably different for each species and might be expressed by a curve, the abscissas of which represent degrees of temperature and the ordinates represent the time factor. The importance of considering the so-called law of the velocity of chemical reaction as influenced by temperature was pointed out and it was shown that the velocity of reaction varies at different temperatures. It was shown that both the so-called thermal constant and coefficient of velocity increase as the temperature is lowered from the optimum of the

species, and that the curve for each species and phase of growth or activity of that species must be plotted before the influence of temperature can be exactly stated. It was then stated that we proposed to determine such curves for a number of common insects which could be reared in large numbers at constant temperatures. This we have done and the results are briefly indicated below. The writer fears that his previous paper was possibly too condensed to bring out the principles suggested and trusts that a certain amount of repetition in the present paper may, therefore, be pardoned.

In the paper cited (24a) the "thermal constant" for insects was defined as "that accumulation of mean daily temperature above the 'critical point' of the species, which will cause it to emerge from hibernation or to transform from any given stage."

This idea of a "thermal constant," or "accumulation of" or "total effective temperature," as expressed by other writers, is a relatively new one in entomological work, although a vast amount of work has been done upon the subject in relation to plant growth by European botanists during the past century. The first attempt to determine such a constant for an insect in America, so far as known to us, was that of Abbe in connection with the hatching of the eggs of the Rocky Mountain Locust (1a). No similar study of the relation of accumulated temperature seems to have been made until that of Simpson (25) in connection with his Codling Moth investigations in 1903. Simpson gave the "effective temperatures" and the accumulation for different stages of growth, merely stating that "effective temperatures" were those over 43°F. In the following year Hunter and Hinds (12) in their discussion of the relation of temperature to the Boll Weevil use the same method and state, "In considering the influence of temperature upon the weevils it has been assumed that, as has been found to be the case with other animals, 43°F. would be about the lowest temperature at which the weevils would be active . . . For this reason it is better to speak of the 'effective temperature,' meaning by that the number of degrees above 43°F." The next year Quaintance and Brues (19x) in their discussion of the relation of temperature to the Cotton Bollworm use the same method, but definitely attribute the origin of the idea to the paper of Merriam (17), and show that 45° gave rather a more constant sum of effective temperatures than when 43°F. was used as a basis. In 1904 the writer (24) endeavored to show a method whereby the emergence of the boll weevil from hibernation could be determined by the accumulation of temperature and in 1906 Newell and Martin (19) made practical use of the data of Hunter and Hinds in determining the time of migra-

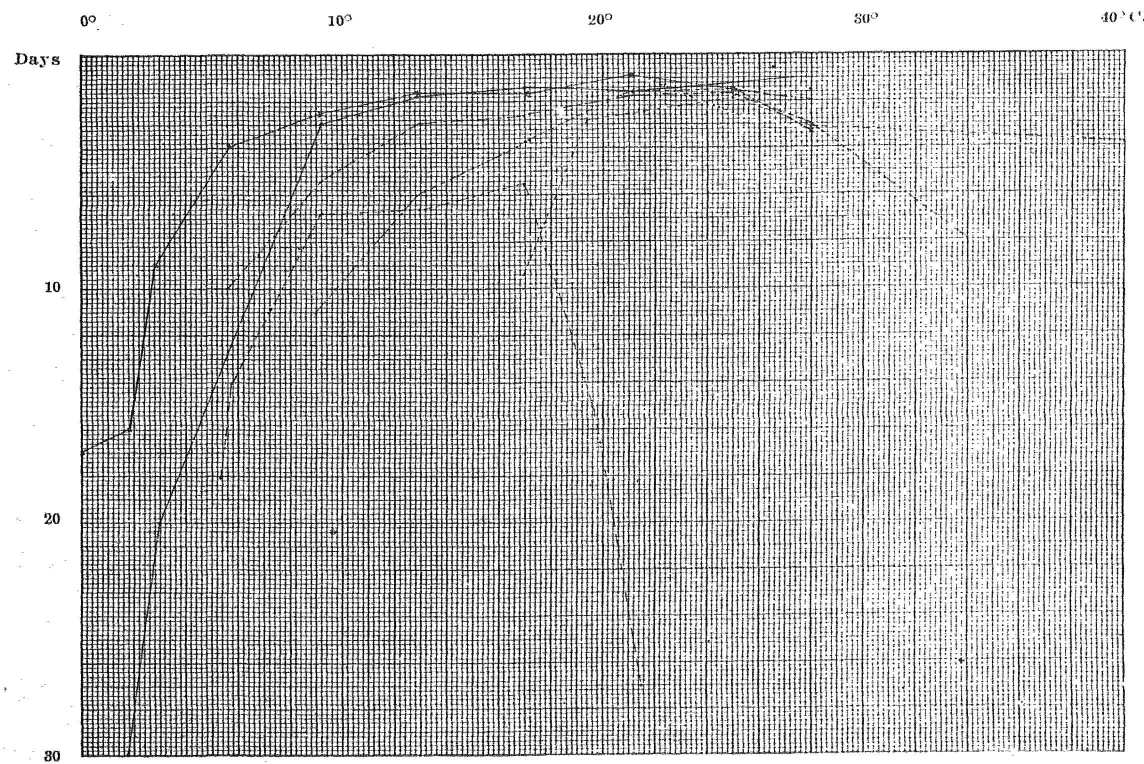


Fig. 6. Germination of seeds at different temperatures according to DeCandolle, as given by Abbe, original. ——— *Lepidum sativum*; ——— x *Sinapsis alba*; ——— ——— *Zea mays*; - - - - *Linum usitatissimum*; ——— — ——— *Trifolium repens*; ——— *Melon, cantaloupe.*

tion of the boll weevil into Louisiana. More recently Hunter and Hooker (13) have made a practical application of the principle in connection with the time of hatching of the cattle tick as related to the time for pasture rotation necessary for its control.

In his previous paper the writer has indicated that the point above which temperatures are "effective" varies with the species and is by no means constant at 43°F. This point was termed the "critical point," but as will be further explained below the term "critical point" is inapt and we believe should be abandoned. The use of 43°F. as the starting point for accumulating "effective temperature" seems to have originated with Merriam, who attributes it to Marie-Davy and other European phenologists. That such a view is wholly untenable and that the point above which growth takes place varies widely with species and their stage of growth is readily seen by an examination of botanical literature. Abbe has cited this literature exhaustively and shows that 43°F. refers only to the germination and growth of wheat, and that each plant has a different "minimum temperature for germination" and growth. He quotes the experiments of De Candolle (4) in the germination of seeds, which are shown graphically in figure 6, showing that growth may commence at 0°C. for *Sinapsis alba* up to 9°C., for *Zea mays*. This has been fully studied by other botanists, notably by Sachs (23) and the literature of the subject has been thoroughly digested by Davenport in his Experimental Morphology, up to 1897, in which he shows that the same principles apply to animals of all classes. That the minimum temperature affecting growth is variable is well shown in figures 24, 25 and 26, in which it may be seen that *Toxoptera* and *Lysiphlebus* may develop at 1.65°C. while *Margaropus* and others will not develop under 5° to 10°C. If then there is no uniform minimum above which the temperature may be accumulated as effective, but this varies with each species and phase

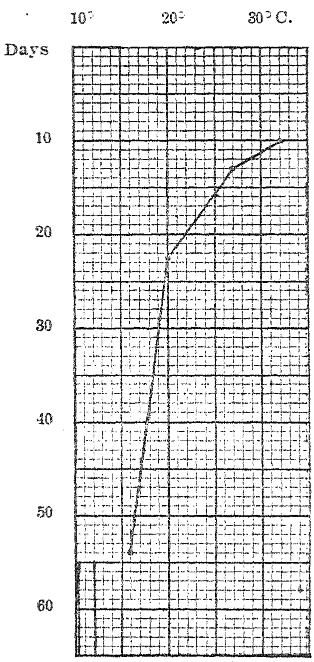
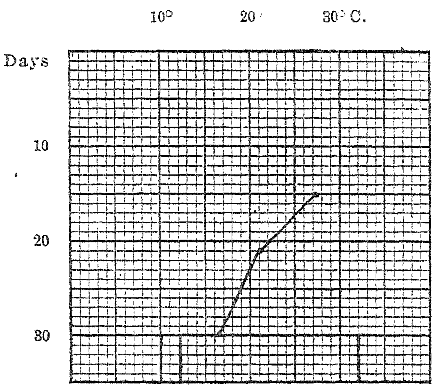
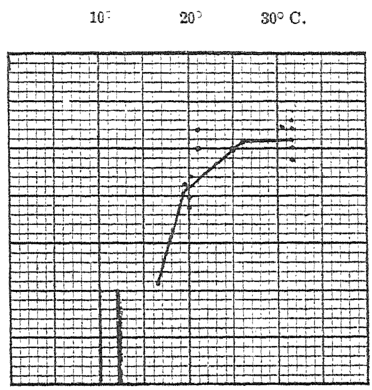


Fig. 7. Relation of temperature to time of pupa stage of *Malacosoma americana* (original).

of growth, if there be no "thermal constant" (*physiological constant* of Merriam) as far as a mere accumulation of temperatures is concerned, and if the velocity of reaction varies according to the range of temperatures; what then is the relation of temperature to the phenomena of insect growth and how may we express it in numerical terms?

To answer this question we must first have facts and then seek an explanation. During the past year we have reared different stages of several insects at fairly constant temperatures. Large numbers of most of the insects have been employed so as to secure fairly accurate averages. Ordinary bacteriological incubators were used for temperatures of 80° and 90°F. An un-iced refrigerator maintained a fairly constant temperature of about 65°F. in winter and 70°F. in





Relation of temperature to the period of incubation of eggs.

Fig. 8. *Euproctis chrysorrhœa.* Fig. 9. *Samia cecropia*, original.

summer. A constant temperature apparatus in which the cold from an ice chamber was balanced by the heat from a gas jet and controlled by an electric thermostat gave close to 60°F. and an ordinary refrigerator was iced so as to maintain approximately 50°F. The details of the work involving a large amount of labor were carried on by Mr. and Mrs. C. F. Jackson, to whom the writer is greatly indebted for the results.

Only an outline of the results will now be given, the details of the experiments being published later. The pupæ of *Malacosoma americana*, figure 7, were transferred to six different temperatures upon pupation and the emergence of the moths noted. At from 16° to 32°C. they emerged in the time shown by the curve, but at 10° and 12°C. all died. It will be noted that from 20° to 30°C. the coefficient of velocity is practically 2, while below 20° it increases very rapidly.

This will be seen to be generally true for the insects cited, as it has been found for most animals and plants so far studied which live at normal temperatures.[1]

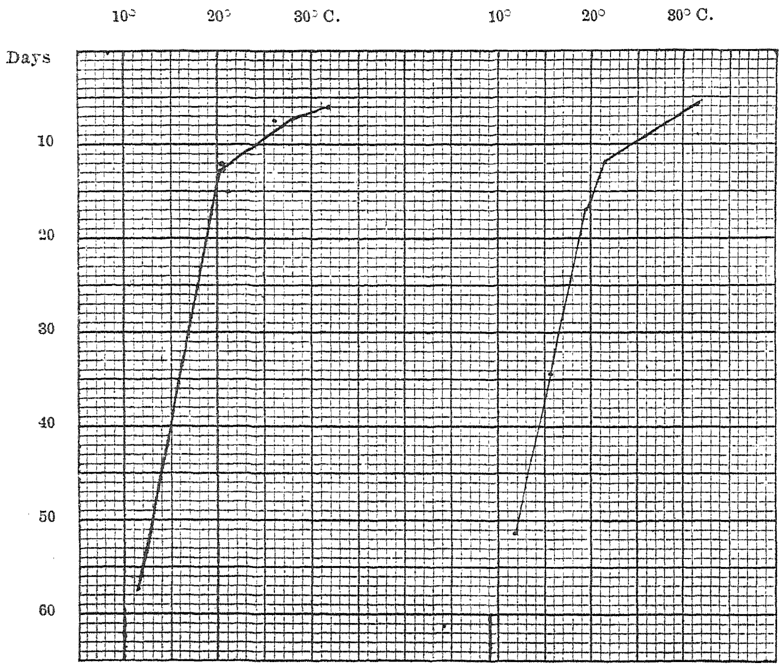


Fig. 10. Relation of temperature to egg and pupal periods of *Tenebrio molitor* (original).

The eggs of the brown-tail moth, *Euproctis chrysorrhœa,* were placed at the same temperatures and their curve is shown in figure 8. They also failed to hatch at 10° and 12°C. and also at 32°C., showing that the latter is above the optimum for a constant temperature. In this

[1] The coefficient or index of the velocity or rate of growth or activity is usually expressed in terms of the difference between two temperatures 10°C. apart, and is expressed by the formula $\frac{\text{Rate at } T_n + 10}{\text{Rate at } T_n}$, in which the rate is the rate of activity or time of growth at the given temperature, T_n. To determine the coefficient between any given temperatures with given rates we have the formula $\frac{\text{Rate at } T_n}{\text{Rate at } T_n + X} \times \frac{10}{X}$, in which X is the difference in temperature between the two points. Thus if the pupa transforms in twenty days at 20°C. and in ten days at 30°C. the coefficient of velocity is $\frac{20}{10} \times \frac{10}{10} = 2$.

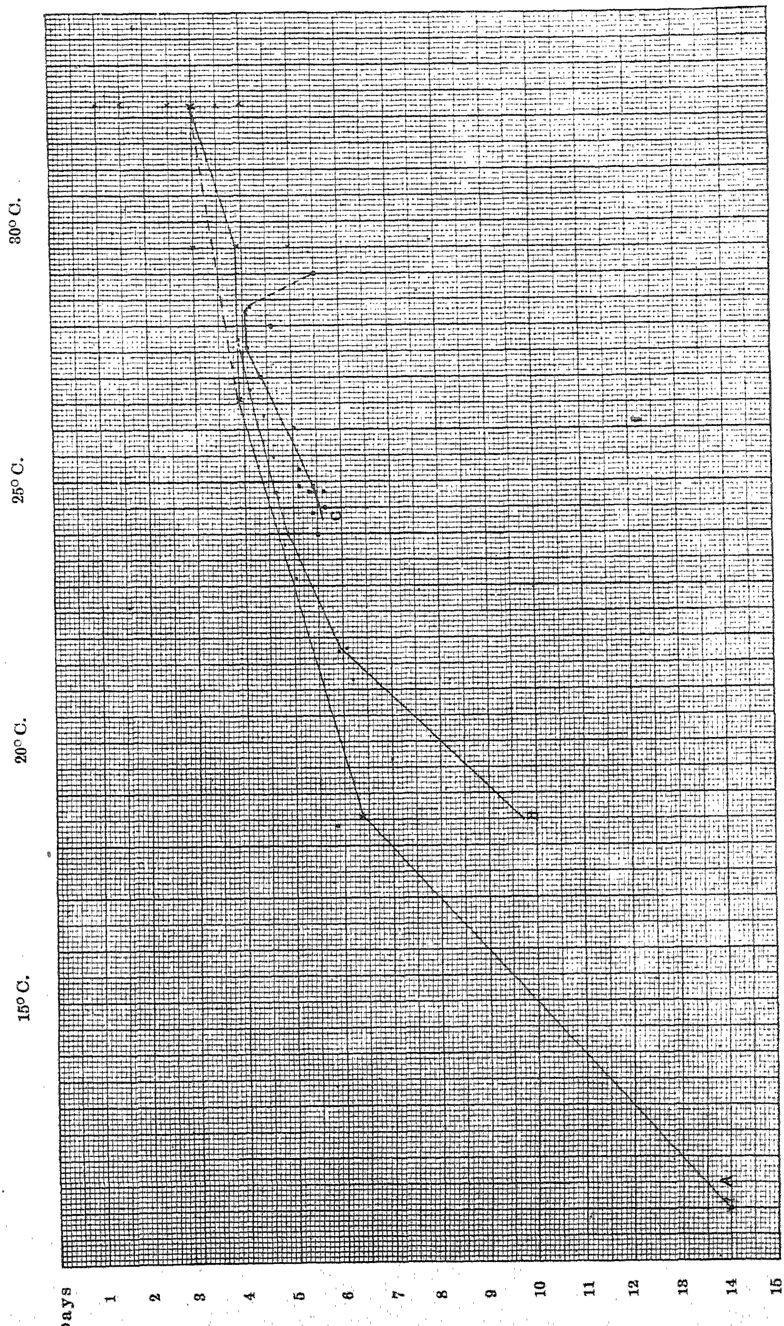


Fig. 11. Relation of temperature to incubation of eggs of *Leptinotarsa decemlineata*. A, from author's data; B, from Girault (Ohio, 1908); C, from Girault and Rosenfeld, Georgia, 1906 (original).

case the coefficient of velocity is greater, being about 3 between 16 and 21°C. and about 2.2 between 21 and 26°C.

The eggs of *Samia cecropia* also failed to hatch at the low temperatures, but hatched at 32°C. though the latter temperature is seen to be above the optimum from the fact that the time did not decrease above 26°C. See figure 9.

The eggs and pupæ of *Tenebrio molitor* were handled in the same manner. The larvæ have also been used, but as yet we have no definite results, owing to difficulty in rearing them under the artificial conditions. The eggs and pupæ both failed to transform at 9° or 10°C. though they did so at 12°C., showing that the minimum temperature for growth is slightly below the latter temperature. The curves, figure 10, for the egg and pupa are of interest as they are based on a large number of individuals and show a similarity which is to be observed in other species, indicating that the eggs and pupæ, where they exist under similar conditions are similarly affected by temperature, while the active larvæ is much more quickly influenced by changes of temperature.

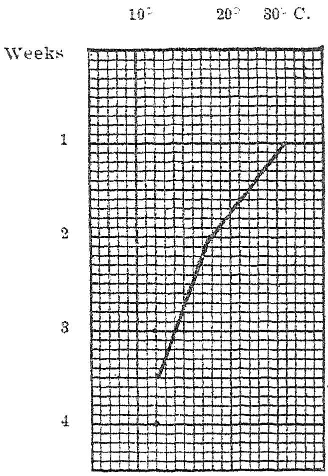


Fig. 12. Relation of temperature to life cycle of *Culex pipiens* according to data of Kerschbaumer (original).

The eggs of *Leptinotarsa decemlineata* were similarly studied and the results are shown in figure 11. The time at 12°C. is questioned because of inaccuracy in the records. The major portion of the curve is of interest when compared with the work of Girault and Rosenfeld in which the time of incubation was determined in Georgia and Ohio under natural conditions, using the average mean daily temperature for the period. It will be noted that the curves between 23.5° and 28°C. are very similar, but that in Georgia the time is prolonged at 29°C., while in our incubators it continued to shorten up to 32.5°C. This may possibly be due to dryness of the atmosphere in Georgia at the time of the observations, of which we have no records. It is known that lack of moisture at high temperatures very quickly lowers the optimum for development. In our own work we have not used apparatus by which we could maintain a constant degree of moisture, but vessels of water have been placed in the incubators and fairly

normal conditions, record of which we have, have been maintained. In exact work to determine the effect of temperature the moisture conditions should be constant, as with many species the moisture influence is as much or more important than that of temperature in determining the optimum for development.

Similar observations on the time of hatching of the eggs of *Malacosoma americana*, the time of emergence of the caterpillars of the brown-tail moth from their winter nests, the hatching of eggs of the gypsy moth, and the pupal stage of *Samia cecropia*, *Papilio asterias* and *Epargyreus tityrus*, have been or are now being made, but cannot be summarized at present.

Other data is at hand, however, showing the same facts. Thus Kerschbaumer (15) has given data from which the curve for the life cycle of *Culex pipiens* as influenced by temperature has been plotted (figure 12), and Regener (21) and Ratzeburg (20) have shown the same for the different stages of *Dendrolimus pini*, shown in figure 13. One of the most careful studies of the relation of both temperature and moisture to the development of an insect is a recent one of Hennings (9) with *Tomicus typographus* Linn. Hennings reared all stages and secured the complete life cycle of this species at four different temperatures with 55% and 96% moisture. Figure 14 shows the curves plotted from his data and shows graphically the effect of moisture as related to temperature for the species. Hennings points out that no thermal constant for the development of the species, which several European students of forest insects had endeavored to determine, could possibly exist as at 24°C. there would be an accumulation of 624° when at 14°C. it would amount to 1400.°

Other activities of insect life as related

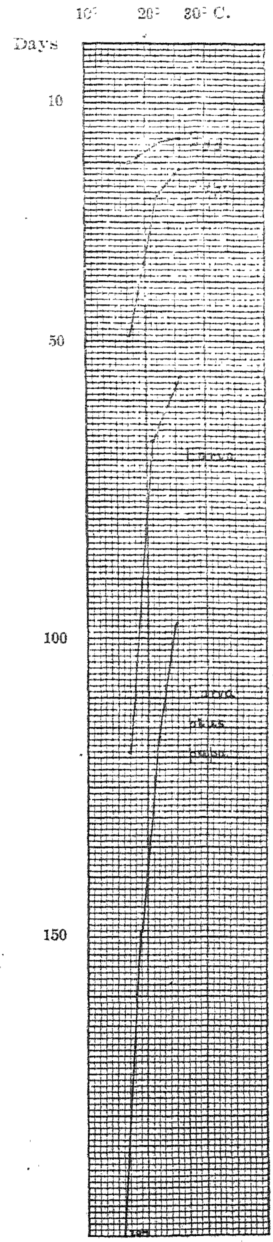


Fig. 13. Relation of temperature to development of *Dendrolimus pini*, from data quoted by Bachmetjew; egg, pupa and larva from Regener, 1865; larva plus pupa

or two of which have been plotted by Bachmetjew (2a). Thus the rate of pulsation of the heart of the silk worm has been given by Tichomirow (26) figure 15, and the food eaten by the larvæ of *Dendrolimus pini* by Regener (21), figure 16, all indicating the same general relation of temperature to insect activity.

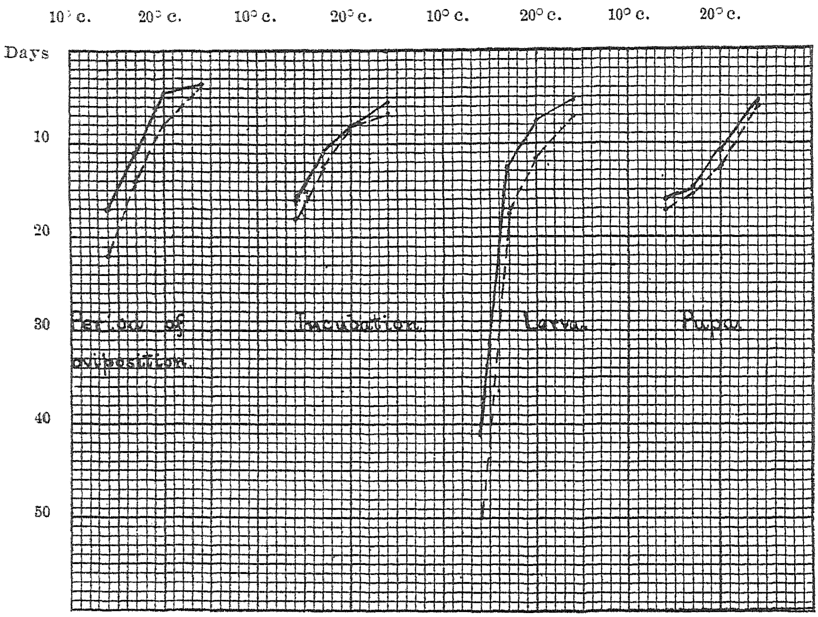


Fig. 14. Relation of temperature to different stages of *Tomicus typographus* Linn; solid line represents 55 per cent and dash line 96 per cent moisture; as given by Hennings (1907), original.

Recent records of some of our own workers have also given data from which we have been able to plot curves which are approximately correct, though the diverse conditions and lack of exact temperature records, make them only approximate. Thus we have taken the weather records for Paris, Texas, for 1904 and have determined the average temperatures for the egg, larva and pupa stages of the Boll Worm as given by Quaintance and Brues, which are shown in figures 17 and 18. The excellent work of Jenne upon the life history of the Codling Moth in Arkansas has given us the best data concerning the egg stage of that insect, which we have plotted in figure 19.[1]

[1] Unfortunately no temperature records are available for Siloam Springs, Ark., where the work was done, but we have used the weather records of Fayetteville, which is but twenty-five miles east and has practically the same climate, so that the average temperature would be almost identical.

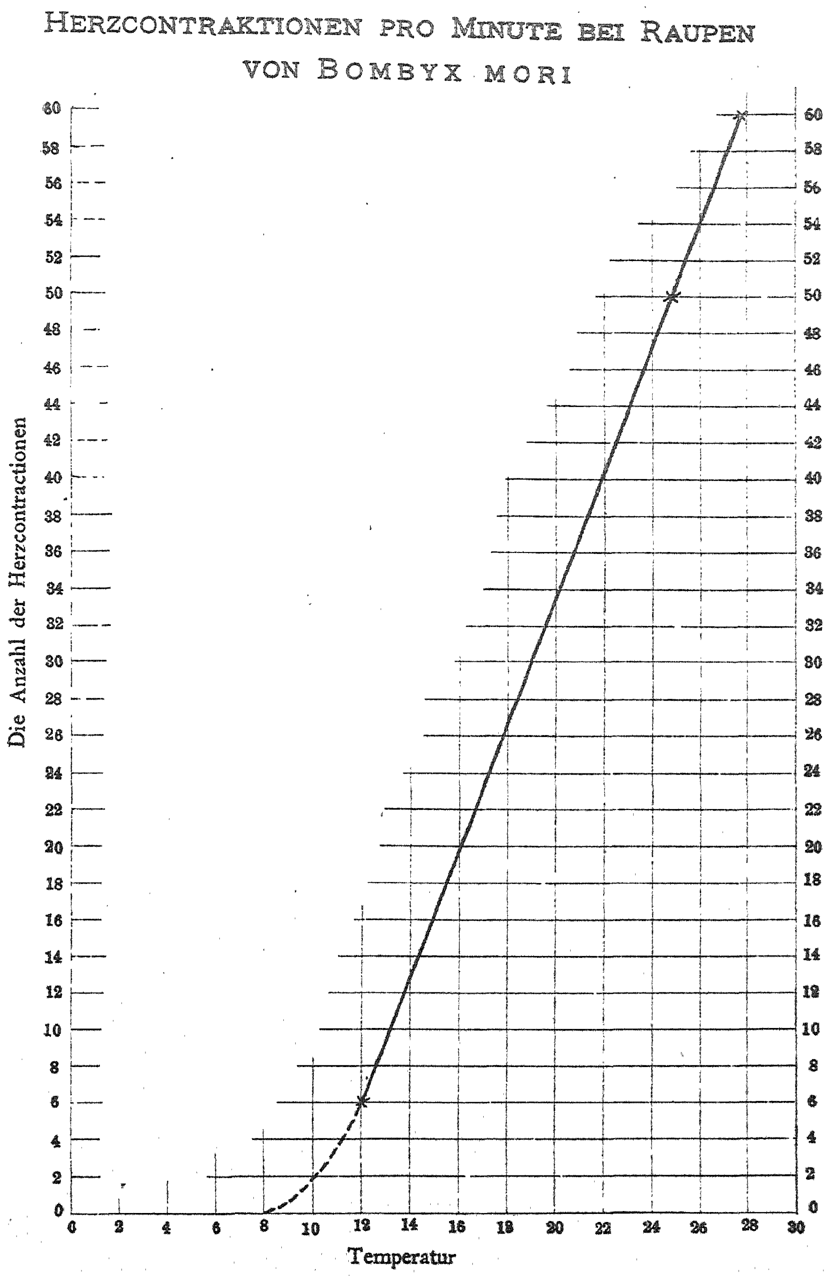


Fig. 15. Relation of temperature to the rate of heart contraction of larvæ of *Bombyx mori*, according to Tichomirow (26), from Bachmetjew.

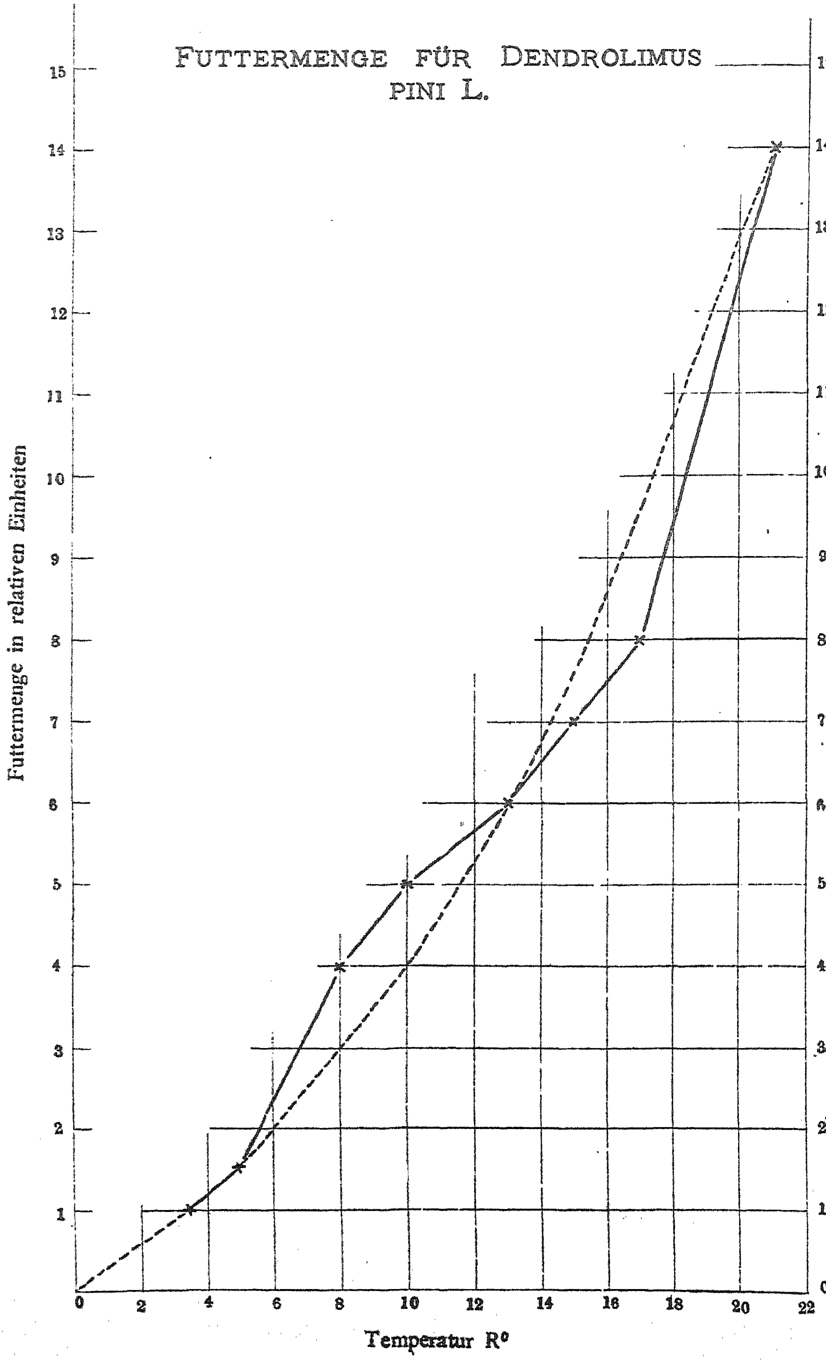


Fig. 16. Relation of temperature to the amount of food eaten by larva of *Dendrolimus pini*, according to Regener (21), from Bachmetjew.

The pupal stage has been similarly plotted from his data, figure 20, and with it are given the records of Melander and Jenne (16) in the Yakima Valley, Washington, in 1904, those of Gillette in Colorado in 1901 and our own for the last four seasons and for rearings made at constant temperatures. It is interesting to note the close approxima-

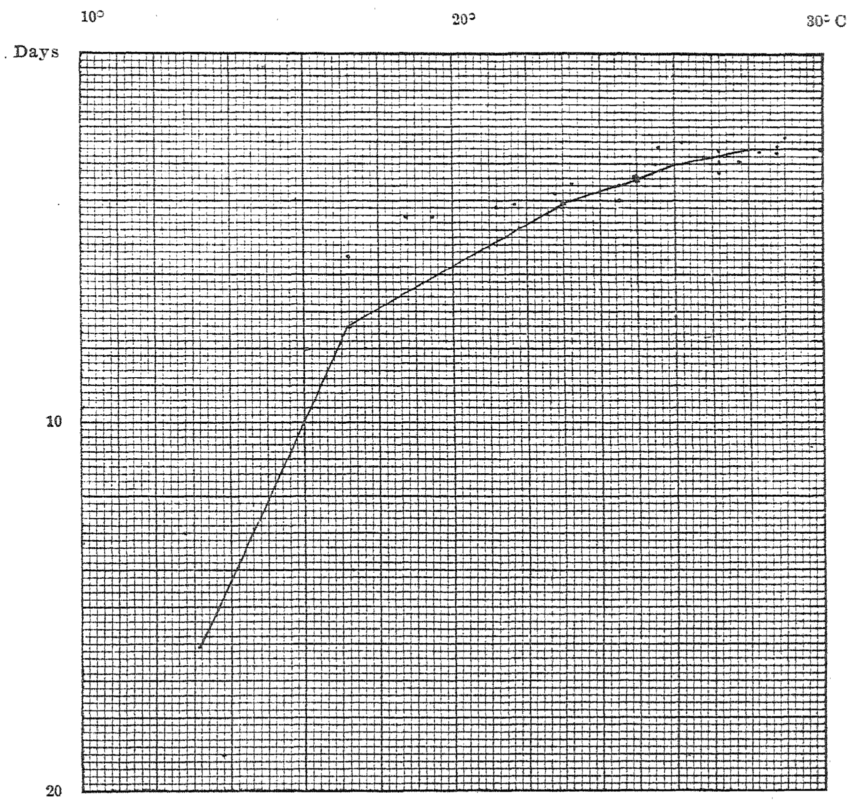


Fig. 17. Relation of temperature to incubation of eggs of *Heliothis obsoleta*, according to Quaintance and Girault (original).

tion to the curve of all this data from diverse sources. Later we hope to be able to make a more complete study of the relation of temperature to the codling moth. The subject is complicated with the pupæ of this insect by the fact that the spring pupæ may be derived from the two broods of the previous year, which may possibly be differently affected by temperature. The curve for the codling moth pupa also shows how quickly it is influenced by temperature, showing why it is that so much longer is required for the pupa in early spring and how

the accumulated temperature decreases accordingly with the advancement of the season. The curve also indicates that but little development of the codling moth takes place below 55°F. and that it is very slow under 60°F.

This data is sufficient to indicate the general relation of temperature to the rate of growth, or activity.

A few days after the presentation of my last paper upon this subject I received the second part of Bachmetjew's Experimentelle Entomologische Studien, published in 1907 (2a). This is an encyclopædic

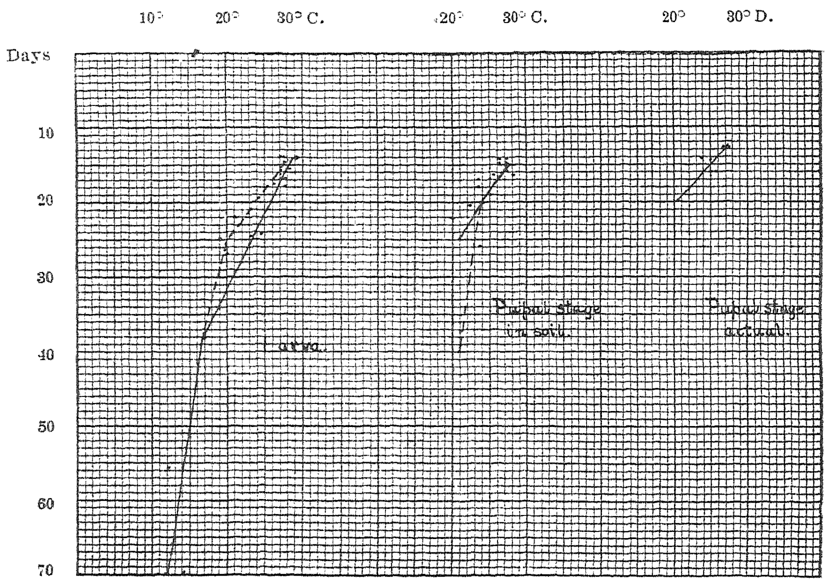


Fig. 18. Relation of temperature to larval and pupal stages of *Heliothis obsoleta*, according to Quaintance and Girault (original).

work dealing with all entomological phenomena in their chemical and physical aspects. It is a monumental work which will serve as a guidebook for entomological students of these subjects in the future. In the first part of this work (2) Bachmetjew dealt with the relation of low temperatures to insect life, but in the second part he discusses the whole range of temperature as related to insect activity and brings out the relation of the temperature and time factors with great clearness. His views are well summarized in figure 21, briefly as follows: (2a, p. 859.) For every species there is a certain range of temperature, K to W, in which it is normally active. At a certain point its growth or activity is most rapid, an increase or decrease of tempera-

ture from this point alike resulting in retarding the growth or activity. This point is the *optimum* (Z.). When the upper temperature limit of activity is passed, at W. heat-rigor ensues. If the heat be increased to a point A, death will result in a short time. This point, A. is known

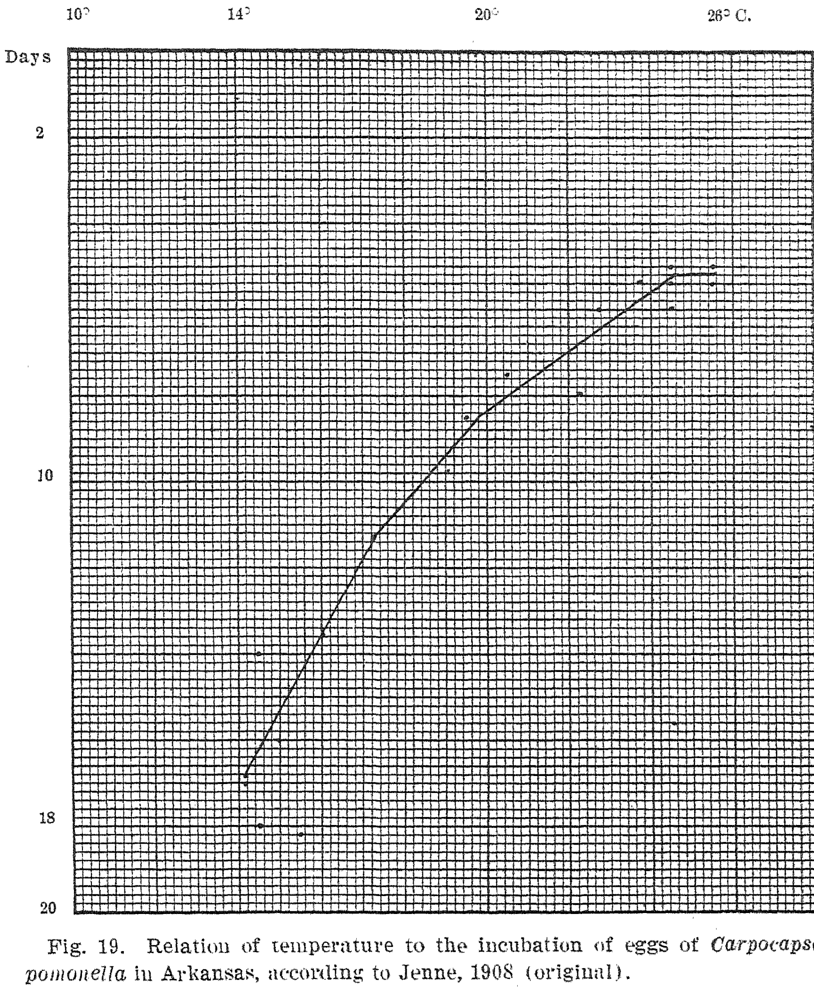


Fig. 19. Relation of temperature to the incubation of eggs of *Carpocapsa pomonella* in Arkansas, according to Jenne, 1908 (original).

as the maximum. But a temperature above A may be endured for a short time before death, but if the insect is brought to a temperature of B death is practically instantaneous due to the coagulation of certain proteids of the protoplasm. Although heat-rigor occurs at any point above W, the effect of it is due to the length of time of the exposure. Thus a varying length of exposure, according to the amount

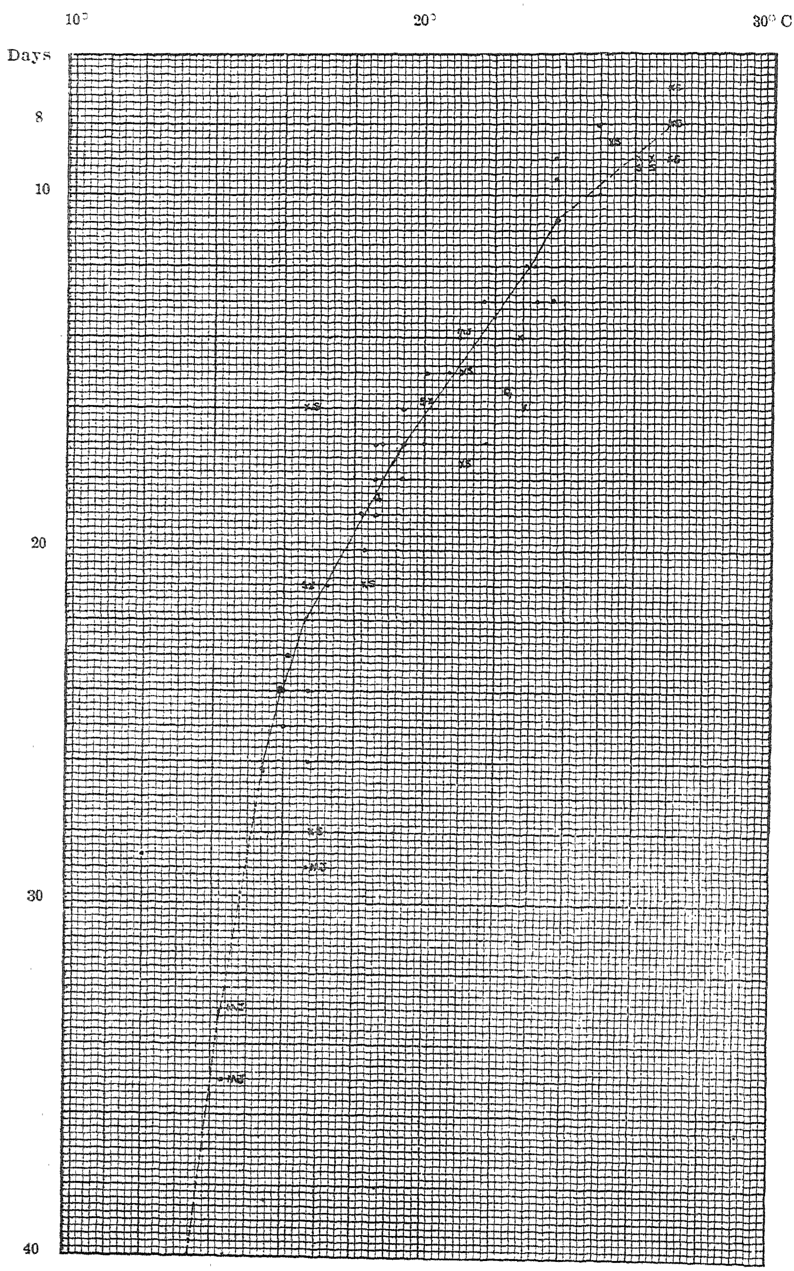


Fig. 20. Relation of temperature to the time of the pupal stage of *Carpocapsa pomonella*:— . . . according to Jenne, Arkansas, 1908; G—according to Gillette, Colorado, 1901; MJ—according to Melander and Jenne, Washington, 1904; XS—from author's data, New Hampshire, 1906–08 (original).

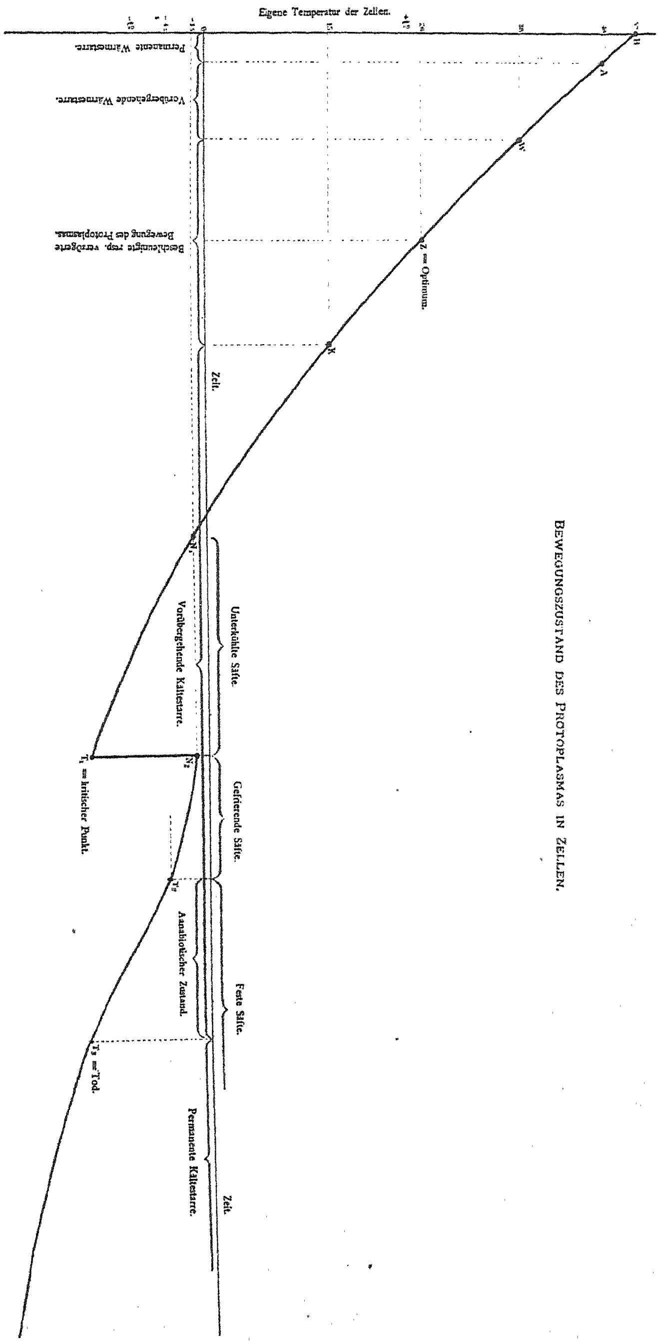


Fig. 21. Scheme of relation of temperature to the movement of protoplasm in the cells according to Bachmetjew, from 2 Bachmetjew.

of temperature, as long as the temperature remains below the maximum A, will not kill the organism if it be returned to normal temperatures, while it will die if maintained at a constant temperature above W. Metabolism does not necessarily cease during heat-rigor at temperatures above W, but is greatly retarded.

If the temperature is lowered, then at a point K, cold-rigor sets in and activity ceases. If it be cooled below freezing to a point T_1, termed the "critical point," the internal heat of the insect rebounds to a point N_2. But if the body temperature again falls below the critical point, as at T_3, then death ensues. If after the critical point has been reached and the rebound occurs, the insect be removed to normal temperatures, it will usually revive, depending upon the length of time it has been under-cooled. As in heat-rigor, metabolism does not cease at temperatures producing cold-rigor, though no activity is apparent, but below a point T_2, all metabolism ceases. Death at low temperatures is held to be due to molecular rearrangement and mechanical injury, whereas death at high temperature is due to chemical changes in the proteids. The relation of both excessive heat and excessive cold is therefore seen to depend upon the time involved and the rapidity with which the organism is cooled or heated and with which it is subsequently brought back to normal temperatures.

This, very briefly, is my understanding of Bachmetjew's views which he supports by the citation of the whole literature bearing on the subject.

In his Experimental Morphology Davenport brought out the same facts as regards both plants and animals, but uses a slightly different terminology. The point at which metabolism ceases at high temperatures is termed the maximum, and at which death is immediate, the ultra-maximum, and likewise, the point at which metabolism ceases with low temperature is called the minimum, and the "critical point" of Bachmetjew upon the maintenance of which death ensues, is called the ultra-minimum. This term is preferable to that of "critical point," for both minimum, optimum, and maximum are critical points in the relation of temperature to the life of the organism, and the term has been so differently used by different groups of workers and by different sciences that it lacks definiteness. The temperature below which cold-rigor ensues is often termed the "minimum temperature for activity" or growth, or germination, but as the true minimum is somewhat below this, we may better term it the *point* of cold-rigor, and the temperature at which heat-rigor commences the *point of heat-rigor,* the latter also being below the real maximum.

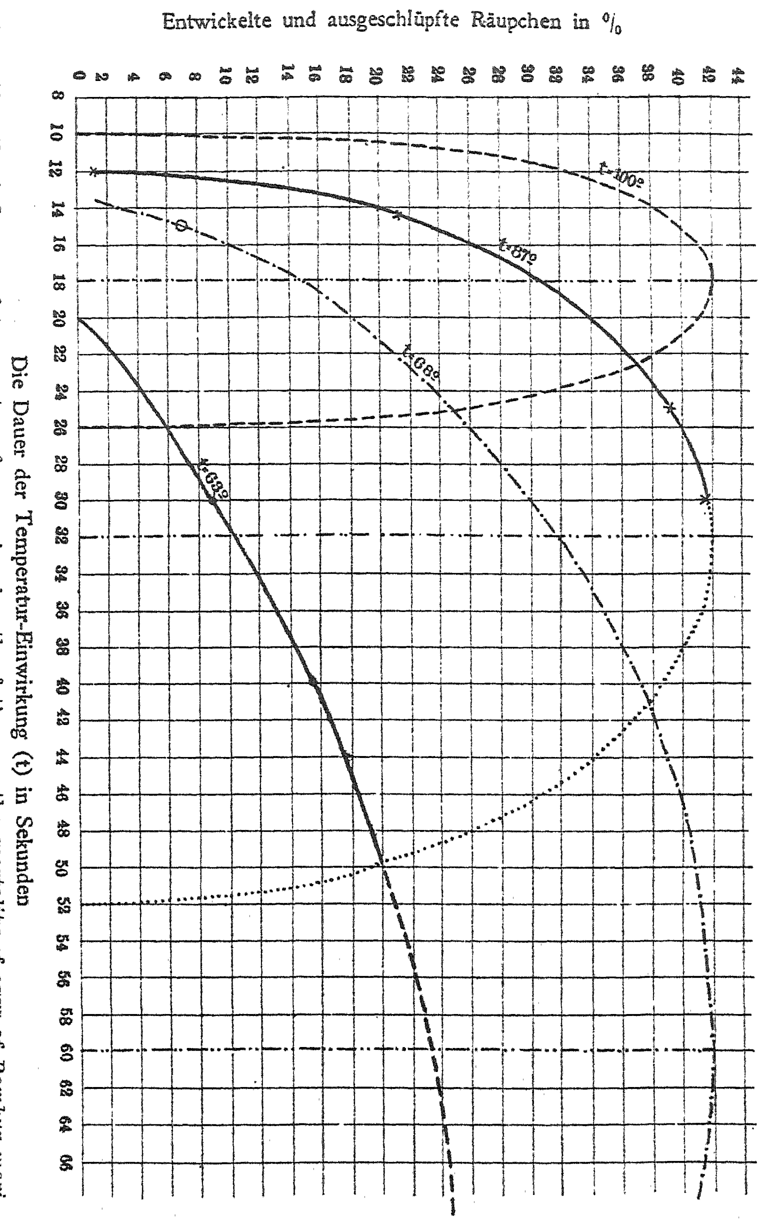


Fig. 22. The influence of temperature for varying length of time on the mortality of eggs of *Bombyx mori*, according to Bellati and Quajat (3), from Bachmetjew.

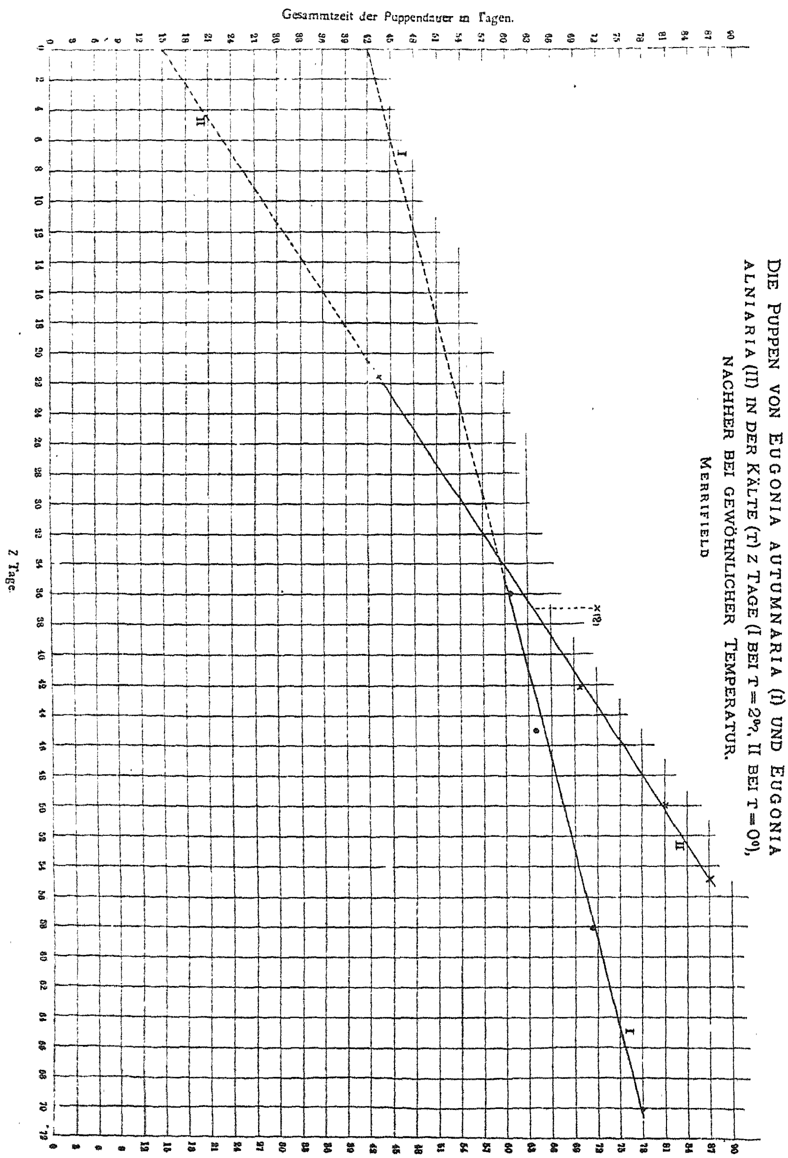


Fig. 23. Relation of temperature to the development of pupæ of *Eugonia autumnaria* and *E. alniaria*, according to Merrifield, from Bachmetjew.

The effect of short exposure to heat above the point of heat-rigor is well shown by the experiments of Bellati and Quajat (3) in which silk worm eggs were maintained at constant high temperatures for a few seconds and the subsequent mortality then noted. The curves in figure 22 show that the higher the temperature the shorter the time eggs may be exposed to it, and although the eggs may be exposed to a lower temperature for a much longer time, if they remain at any temperature above that of heat-rigor, they will die.

The fact that metabolism continues at low temperatures has been shown by Merrifield (18) in his experiments with pupæ of *Eugonia autumnaria* and *alniaria* exposed to 2° and 0°C. respectively for varying lengths of time and then developed at room temperature. As shown in figure 23, the pupæ of *E. autumnaria* at 2°C. as the time for emergence after they were brought to normal

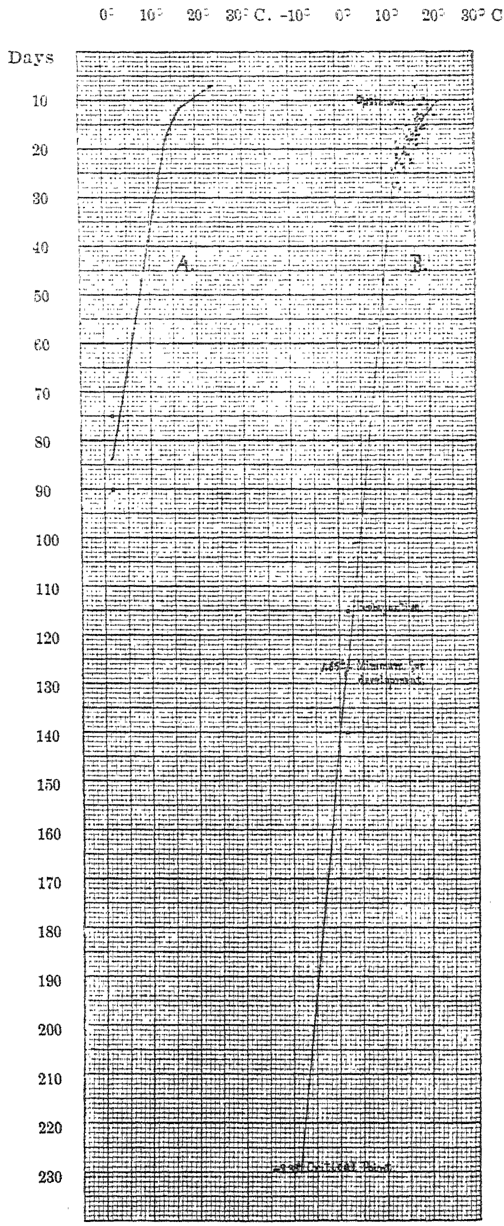


Fig. 24. Relation of temperature to the development of *Lysiphlebus tritici*, A, and *Toxoptera graminum*, B, according to Hunter and Glenn (original).

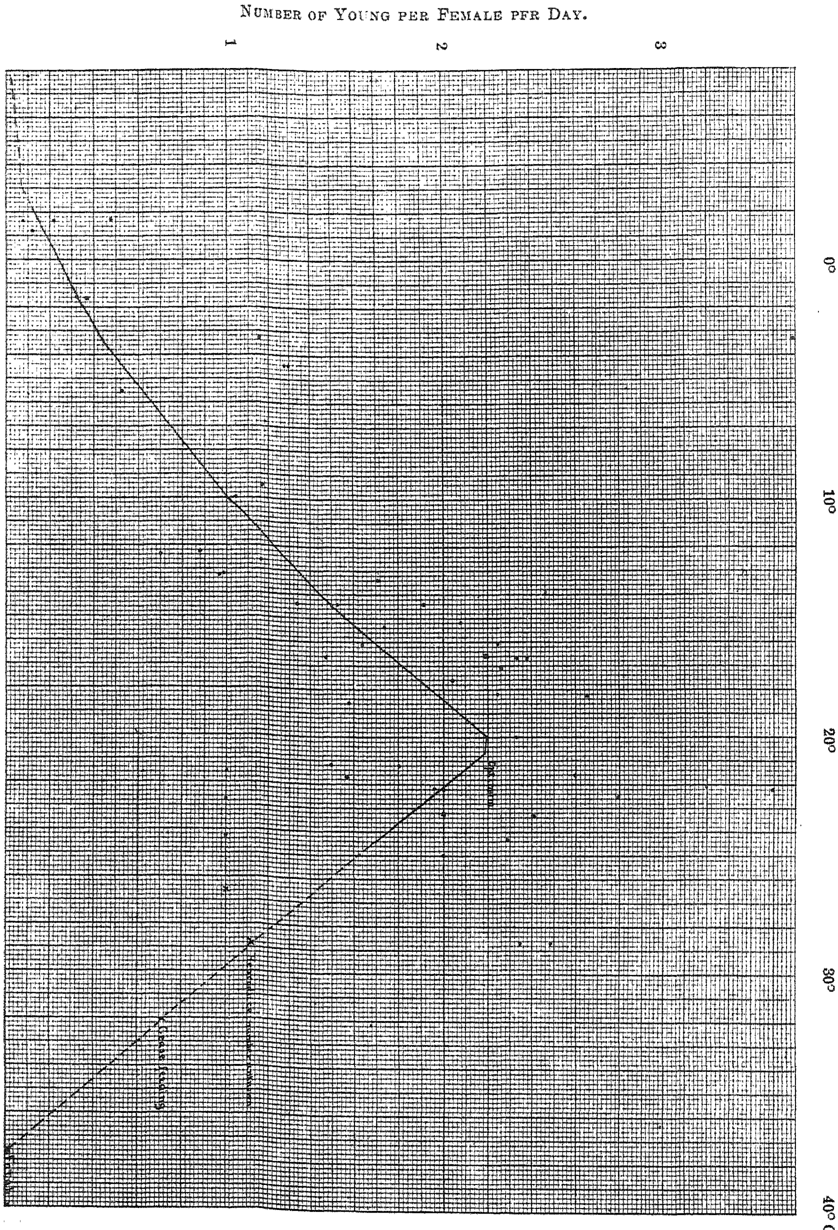


Fig. 25. Relation of temperature to the number of young borne per female per day of *Toxoptera graminum*, according to Hunter (original).

temperature was less the longer they were held at 2°C., while the pupæ of *E. alniaria* showed no development at 0°C. and their subsequent development was retarded by it. Evidently the former species was slightly above, and the latter slightly below its respective minimum. It is known that short exposures to temperatures below the minimum retard the development of some species and hasten that of others, depending upon the species, the temperature and the time exposed.

The influence of low temperatures has also been nicely shown in the studies of Hunter and Glenn (11) on the Green Bug (*Toxoptera graminum*) and its parasite *Lysiphlebus tritici*. The rates of growth of these insects are shown in figures 24 and 25, which are plotted from the records given, showing that development may take place at a mean 1.65°C., while the point of cold-rigor is slightly higher for *Lysiphlebus*, which shows no activity below about 4° or 5°C., while the ultra-minimum or "critical point" of Bachmetjew, at which death occurs, is about —8.33°C. or 17°F. Similar phenomena are shown by the rate of reproduction of *Toxoptera* as plotted in figure 25, in which it is seen that reproduction may actually occur at a daily mean of —7.8°C. and that it is frequent at a daily mean of 0°C. This curve is of additional interest, however, because it gives the optimum of the species, about 20°C., from which the rate of reproduction gradually decreases, though it is known to occur at about 29°C. until the aphides cease feeding at 32°C. and death ensues at 37.5° to 40°C.

It is interesting to contrast these points of cold-rigor hovering around 0°C. with those of the Bollworm which is about 10°, as well as several others previously cited, and that of the Cattle Tick which is about 5°C. It is evident, then, that the point of cold-rigor and the minimum must be determined for each species, and for each phase of its growth. Dr. L. O. Howard (10) has given these points for several houshold pests and has shown how such a knowledge may have most practical value in the prevention of insect injury in cold storage. Similar data has been given by Duvel (6) for weevils affecting cowpeas. Recently a tobacco manufacturer has applied to us for aid in the destruction of a pest of stored tobacco, which we believe may possibly be accomplished by the use of low temperature.

From the above data it is evident that any accumulation of temperature to secure a thermal or physiological constant cannot be based on a mere addition where variable temperatures are involved, for it is evident that every degree has a different value in relation to the time factor. Thus as the mean temperature rises with the advance of the season both the time for the pupal stage and the total accumulated

temperature for the pupal stage of the codling moth decrease with the advancing season. Though a fairly constant "total effective temperature" for any given phase of an insect's life or activity may be secured for the summer months when there is a fairly constant mean temperature, such an accumulation will have no meaning in regard to the same phenomena in spring and fall when the temperatures are more variable. Thus in the total "effective temperature" in the hatching of the eggs of the cattle tick as given by Hunter and Hooker, eggs laid from September 15 to October 15 require a total of 837.6° to 1,510.8° over 43°F. to hatch, while those laid in April and May require from 981.6° to 1,139.1° accumulation. Were the moisture factor also considered, it is evident that the range of such an accumulation is too large to make it of much practical value, except by always using the minimum possible.

Thus if we are to relate the phenomena of insect growth and activity to temperature, we may say that they will be *about* so and so between certain temperatures or at certain seasons when such temperatures normally prevail, as Hunter and Hooker have done in the case of the cattle tick. Or, if we wish to be exact, we must secure the temperature curve for the species, based on the observation of a considerable number of individuals kept at different constant temperatures, or possibly better at temperatures having a diurnal variation with constant maximum and minimum, and with fairly constant moisture conditions. That the moisture factor must not be neglected is shown by the work of Hennings (lc.) and by that of E. C. Cotton, on the cattle tick, presented before this association, but never published.

With such a curve plotted it would be possible to give each degree of temperature for whatever time unit used, a definite valuation in relation to the accumulation of temperature necessary for any stage of growth or activity at the optimum temperature. Thus in the case of the cattle tick, see figure 26, if the optimum be considered to be 28°C. at which temperature 21.5 days are required for the eggs to hatch, then each day at 28°C. has a value of 4.65% of the whole, or .0465. As twenty-five days are required at 25°C., each day at 25°C. has a value of .04, and so on the value of a day at 20°C. is .02, at 15°C. is .01, and at 11½°C. is .00666. A table for the value of the degrees between these points may now be made so that the valuation of every degree to be considered may be given. Using these values, when an accumulation of 100% or 1 has been secured the true "thermal constant" should have been reached, for all the time relation to the varying temperatures has been reduced to a common unit. Were the effect of moisture similarly studied so that the effect of different

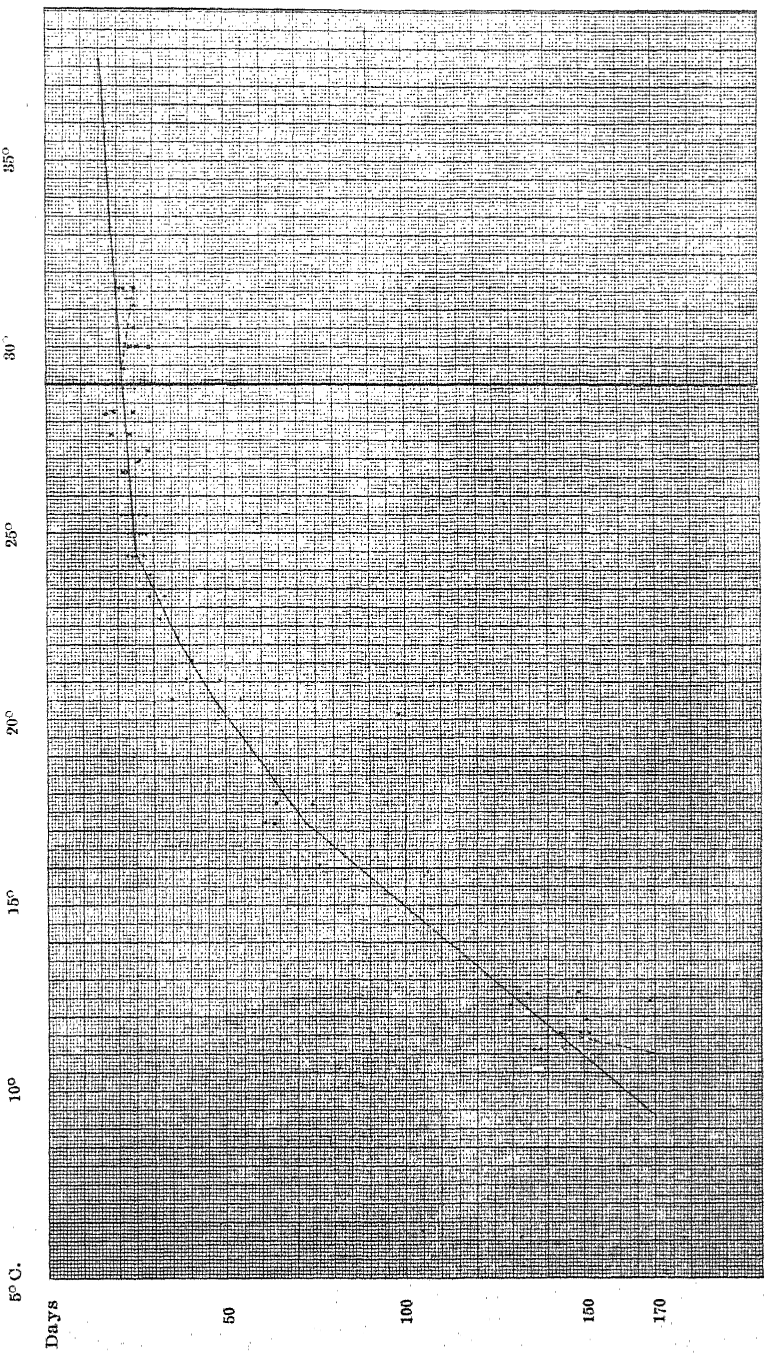


Fig. 26. Relation of temperature to the incubation of the eggs of *Margaropus annulatus*; . . . from Hunter and Hooker (Dallas, Tex., 1906), x from Newell, Baton Rouge, La., 1905-06 (original).

degrees of moisture at each degree of temperature were known, it should be possible to give a valuation for each degree of temperature which when the total equalled 100% or 1 would give the true physiological constant for the stage of growth or activity concerned. Such a proceeding would, of course, be entirely impractical except in the case of an insect of great economic importance in the control of which the application of such data would have immediate practical value, as in the case of the cattle tick. But if we are to deal with temperatures in relation to entomological phenomena, and are to give the matter any study at all, we may as well seek to have an understanding of the principles concerned even though we may not always use them in an exact manner. How closely accumulations of temperature values made by the above method will agree with the observed phenomena under varying conditions the writer has not had opportunity to determine, though the computations are now being made. The method seems, however, to be much more exact from a theoretical standpoint, than any heretofore advanced, and whether it includes all the factors necessary to determine a thermal constant or not, it is evident that some such process of computing the values of each degree of temperature from a curve established for each stage of growth, and by which they are reduced to a common basis, must be used before there is any possibility of securing a thermal constant for any given phenomenon of growth where subject to varying temperatures.

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MR. HEWITT: I should like to thank Professor Sanderson for his most interesting paper on the relation of temperature to the growth of insects. I think one of the most important features of his address is that he has given a very excellent summary of Bachmetjew's

work, which, although well known to some of us, may not be known to many practical entomologists, and he has pointed out lines which can be followed up by those who wish to study insect control, and I believe that in a few years we shall have results of a practical value accruing from these studies. One of the most difficult insects to control at present is the fruit fly, or apple maggot (*Trypeta pomonella*), and it is stated by Mr. C. P. Lounsbury, Cape Colony, South Africa, that by keeping the fruit for three weeks at a low temperature, the contained maggots of *Ceratatis capitata* were killed. I should like to suggest that temperature records should be kept in Centigrade rather than Fahrenheit, as the former is the method which is now used on the continent for all scientific work.

In studying a number of Dipterous larvæ upon lines similar to those of Professor Sanderson, I have confirmed the idea that the different stages of life history, such as larva and pupa, are all individually affected by temperature, and that temperature affects the life history, not as a whole, but by affecting each instar and stadium individually.

I think we are all extremely indebted to Professor Sanderson, and I wish again to offer him my sincere thanks.

Secretary Burgess: I think this paper is very important, and one with which we should get in close touch. It is one, however, which requires considerable study. The matter of temperature plays a very important part in the parasite work which is being conducted at the Gipsy Moth Parasite Laboratory.

President Britton: We will now listen to a paper by E. C. Cotton, Knoxville, Tenn.

A CONSTANT LOW TEMPERATURE APPARATUS FOR BIOLOGICAL INVESTIGATIONS

By E. C. Cotton, *Knoxville, Tenn.*

One would probably be well within the truth in saying that every working entomologist has "pigeonholed" several fundamental problems in economic entomology the solution of which he has been obliged to defer because of the lack of funds, time and special apparatus. The passage of the Adams Act by the National Congress made it possible to commence the solution of some of these basic problems, most of which will require several years to complete. Under the provisions of this Act men in the experiment stations all over the country are devoting their whole time and energy to the working out of single

problems, and, what is more promising of results, they are usually provided with ample funds to secure the special apparatus needed in their work.

At the Tennessee Station we have one of these problems and for the solution of certain phases of it we soon discovered that apparatus for securing and maintaining constant low temperatures was essential. A careful search through the catalogs of both domestic and foreign firms dealing in laboratory supplies convinced us that there was nothing on the market to satisfy our particular needs. Incubators and other devices for securing and maintaining constant temperatures above the melting point of ice were listed by all of them but nothing for temperatures below that point. We then set to work to devise and construct a piece of apparatus for this purpose, which, because of the intense interest expressed by those who have seen it in an incompleted condition and its wide applicability to biologic problems, it has seemed advisable to describe at this time.

Our particular problem concerned itself with the North American Fever Tick and the effect of low temperatures upon the various phases of its life cycle. We know that a certain low temperature is fatal to all engorged adult ticks under a given set of conditions and also that a lower temperature under another set of conditions will not seriously affect them. Why? What are the governing factors and under what conditions do they act? We know that low temperature inhibits egg laying. What is the critical temperature for this function? Ever since the successful application of the law of accumulated effective temperatures to the boll weevil problem, there has been a demand from those engaged in tick investigation work for a similar law relating to the fever tick. Mr. Hunter's paper entitled "A Tentative Law Relating to the Incubation of the Eggs of *Margaropus annulatus*," which was presented before this Association two years ago, was an attempt to satisfy that demand. Recently we have attempted to apply this law to the immense mass of data accumulated at the Tennessee Station during the past three years, but I cannot flatter myself that we have achieved any great success. The trouble is that the upper and lower limits are too far apart and the exceptions too many and too serious. There seem to be some controlling factors which we have not yet mastered. What are they? These are all questions of vast importance from an economic point of view and moreover questions that must be answered if we are to know the fundamental laws on which to base a more successful scheme of tick eradication.

Various investigators have felt the need for low temperature con-

trol and have used many devices to secure this end. Among other things ice cream freezers and domestic refrigerators have been drafted into service, the cooling agent in all cases being ice with or without salt. In this way they were able to secure temperatures down to the melting point of ice, but anything like constant temperatures below about 42° or 43° Fahrenheit were out of the question. This method is very unsatisfactory at best, as it requires a great deal of personal attention and introduces the factor of human fallibility. As we wished to go below 32°F. and to maintain the temperature constant for long periods of time we soon saw the necessity of artificial refrigeration.

The list of active agents used in artificial refrigeration is not an extensive one, hence our choice of the gas we would use was not difficult. Anhydrous ammonia, which is probably the most widely used agent, was soon eliminated for the reason that our plant was to be installed in the basement of the agricultural building, in which, in addition to the laboratories for the regular Station workers, are located class rooms and laboratories for the accommodation of a large number of students. The presence within this building of any considerable quantity of so penetrating and irritating a gas as ammonia could scarcely be attended with anything less than serious inconvenience. Then, too, in our investigations we are dealing with living animals, hence small leaks, which are almost sure to occur when working with high pressures, might result disastrously.

Sulfur dioxid was soon disposed of for the reason that the gas is highly poisonous and also that the compressor using it operates with a partial vacuum on the low pressure side. While this machine is quite efficient when air can be kept out of the system every one recognizes the fact that a vacuum is very difficult to maintain and a little air leaking in seriously lowers the efficiency.

This process of elimination left only carbon dioxid, which was finally chosen. Safety and non-offensiveness of the gas were the principle factors in this determination. With this gas leaks of considerable magnitude can exist without serious inconvenience to the operator or other occupants of the building. There is also practically no danger that the insects or other life under investigation will be killed off in the middle of an experiment requiring several months to complete, even if the whole charge of gas were to escape into the room.

The plant (Pl. 6) consists of a compressor of two tons refrigerating capacity, a 7½-horse-power motor, a brine tank of 200 gallons capacity containing the expansion coils, a brine pump and an insulated box containing four chambers, each supplied with cooling coils

through which the brine circulates. The flow of brine through each of these coils is controlled by a balanced valve operated by a thermo-regulator.

The compressor is of the two-cylinder upright type and when in operation the high and low pressure sides stand at 70 and 30 atmospheres respectively. The machine is so strongly constructed that there is no special danger attendant upon its operation at these high pressures. A motor of 6½-horse power is required to operate this machine and a reserve of at least 1-rated horse power should always be allowed for a compressor of this size, more for larger sizes.

The brine system consists of a brine tank, pump, coils and the necessary piping to connect them. The brine tank is constructed of 3-16-inch boiler plate, is 3 feet in diameter and 4 feet high and contains 200 lineal feet of expansion coils giving a radiating surface of about 68 square feet. This tank holds approximately 200 gallons of calcium chlorid brine, which we are using in preference to sodium chlorid brine because the latter is so destructive to iron piping. The brine piping, with the exception of the coils in the chambers, which are 1 inch, is ¾-inch galvanized water pipe (Pl. 7.). The brine tank, piping and pump are well insulated against loss of cold by a wrapping of two thicknesses of 1-inch hair felt with one layer of waterproof insulating paper between. A tight-fitting cloth cover is then fastened over the whole and painted to keep out moisture (Pl. 6).

The brine is circulated by an automatic water lift or pump, operated by city water pressure. The pressure of the brine in the pipes, between the pump and the balanced valves, is automatically maintained equal to that of the water acting on the pump. When any one of the four valves is opened the brine flows through, reducing the pressure and starting the pump, which continues to operate until the valve closes and the pressures in the water and brine systems again balance. The brine tank thus serves as a storage reservoir for cold, which is automatically fed into the coils as needed to maintain the desired temperatures in the chambers.

The insulated chambers consist of a box 10 feet long, 3 feet wide and 3 feet high, the interior of which is divided into four compartments, each 2 feet square inside. The outside walls consist of an outer and an inner casing of ⅞-inch matched pine ceiling with four thicknesses of 1-inch hair felt and five layers of waterproof insulating paper alternating between. The inside partitions, between the chambers, are built up of two walls of ⅞-inch matched pine ceiling with three thicknesses of 1-inch hair felt and four of paper alternating between. Each of these chambers is to be maintained at a dif-

ferent constant temperature: No. 1 at 60°, No. 2 at 50°, No. 3 at 43° and No. 4 at 32°. The radiating surfaces of the coils were estimated to easily maintain these temperatures, being 453, 733, 1,153 and 1,453 square inches respectively.

In one side of each chamber is a door 15 inches each way, which seats on two felt-lined surfaces and is fastened by the usual eccentric refrigerator door hasp. In each door is a window, 9 by 10 inches, containing six panes of glass with five air spaces between (Pl. 8).

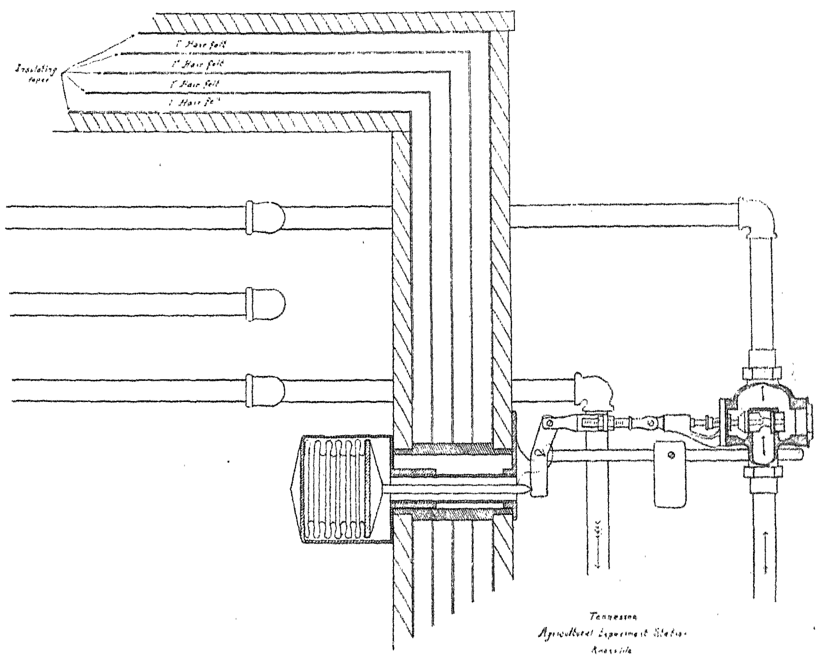
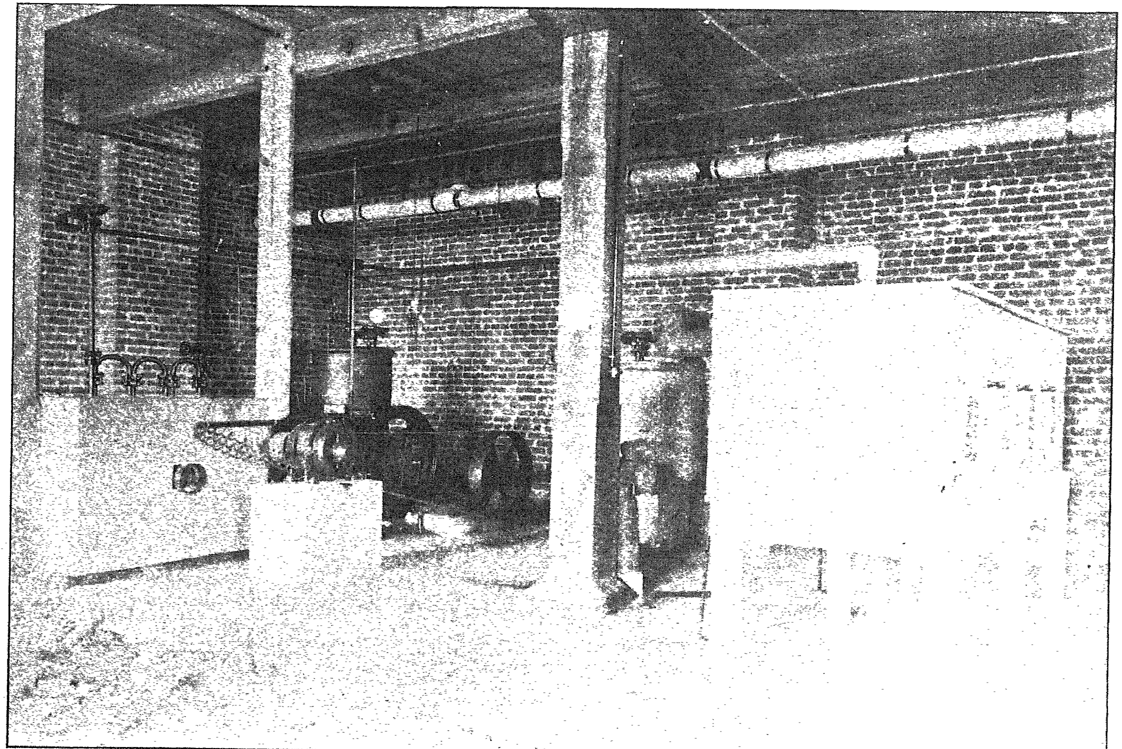


Fig. 27. Section through wall of cool chamber, showing thermo-regulator and balanced valve with connections.

The insulation of these chambers is so nearly perfect that there can be but little loss through the walls.

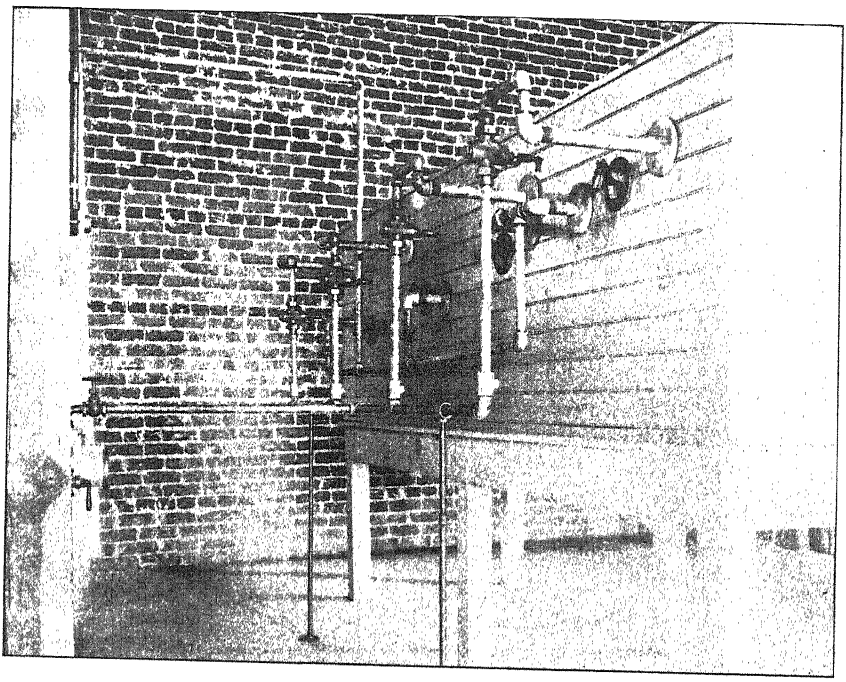
The desired temperatures are secured by pumping the cold brine through the coils, which are placed in the upper part of the chambers. This arrangement allows the free use of the floor of the chamber and also locates the coils at the point of highest temperature and theoretically should yield the best results. Inside the chambers and just below the coils are located the bellows of the thermo-regulators. This location gives a quick response to any changes of temperature of the coils themselves.

Plate 6

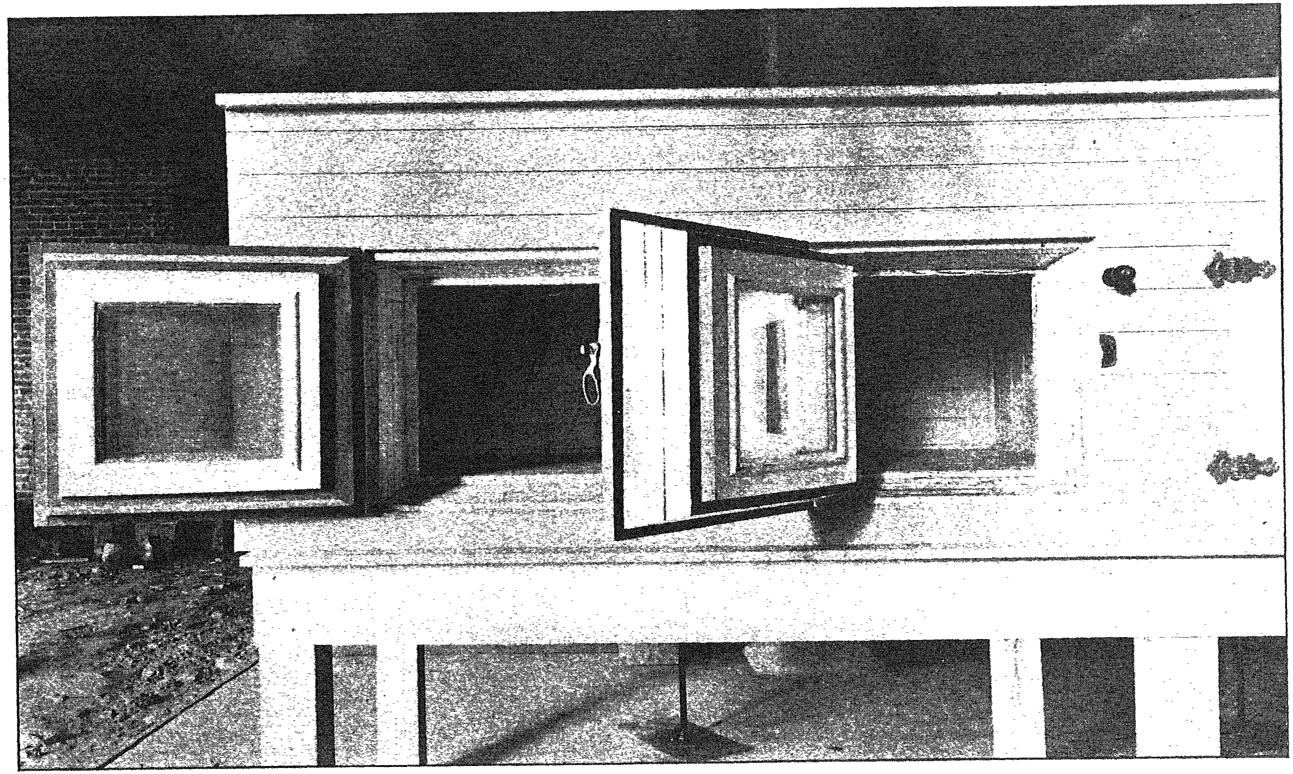


View of complete plant

Plate 7



Back side of cool chambers showing brine piping and balanced valves before insulation was applied



Front view of cool chamber showing construction of doors

The thermo-regulators, which are the vital part of the plant, were made by a local firm. The mechanical principle involved constitutes the most important forward step in temperature control that has been made in the past century. They are simple, extremely sensitive, reliable and almost indestructible if properly handled. The regulator is in the form of a very thin, steam brass bellows about 5 inches in diameter and 3½ inches high and is partly filled with an easily volatilized liquid after which it is hermetically sealed.

A rise in the temperature of the air in the chamber causes a portion of the liquid to volatilize, exerting an expansive pressure on the bellows, which is so housed that it can expand in one direction only. To the free end of the bellows is fastened a pin which extends through the wall of the chamber, and engages the lower end of a rocker arm to the upper end of which is attached the stem of the balanced valve.

The balanced valve remains closed so long as the air in the chamber is at or below the temperature for which the bellows is adjusted. When the temperature rises above this point the bellows expands, exerting a thrust against the lower end of the rocker arm, opening the valve and allowing the cold brine to flow through the coils until the temperature again falls to the predetermined point. Adjustment is secured by means of a 5-pound sliding weight carried on a rod 12 inches long, projecting at right angles to the rocker arm (Fig. 27).

In actual practice the valve is probably never opened wide. The rising temperature begins to act on the liquid in the bellows before the temperature for which the latter has been adjusted is reached. This opens the valve the merest trifle, allowing a very thin stream of the colder brine to pass through and mix with the body of brine already in the coils, reducing its temperature and closing the valve before enough brine has passed through to entirely replace that present when the valve began to open. A pressure of 10 to 15 pounds on the brine system admits of a more sensitive control than a higher one because with the higher pressure the whole body of brine in the coils is pretty sure to be replaced by brine several degrees colder before sufficient cold radiates from the coils to close the valve, consequently the temperature of the air in the chamber will be carried several degrees below the desired point before the balance is again established between the brine and the air.

MR. CONRADI: I would like to ask the cost of this low temperature apparatus, as described.

MR. COTTON: About fifteen hundred dollars.

MR. CONRADI: And what is the daily cost of operation?

MR. COTTON: About seventy-five cents.

PRESIDENT BRITTON: The next paper on the programme is by Mr. E. F. Hitchings, Waterville, Me.

THE UNPRECEDENTED APPEARANCE OF THE SADDLED-PROMINENT

(Heterocampa guttivitta)

By E. F. HITCHINGS, *Waterville, Me.*

Past History. This insect has appeared in the writings of eminent entomologists under at least five different genera and ten different species, but it has never been regarded as of enough importance to receive a common name until the season of 1908, when, on account of its extensive ravages in Maine, it was by mutual agreement of the Experiment Station and the Maine Department of Agriculture called the Saddled-prominent.

Doctor Felt, in his twenty-third report of New York, has suggested the name "Antlered maple caterpillar." This is open to criticism, for in the first place the caterpillar remains in the antlered stage for only a few days, in the second place maple is not its favorite diet. It prefers beech above all other food plants. During the recent invasion it fed freely on such other trees as oak, white and yellow birch, maple, hornbeam, hazel, apple, pear, plum, cherry, etc.

The insect was first named by Walker in 1855. Beginning in 1864, Packard assigned it to no less than two genera and five species, while Walker seemed to vie with him and placed it under three genera and four species. It did not come into prominence sufficiently to be mentioned in *Insect Life*.

Distribution. I quote from the fifth report of the Entomological Commission: It was reported as found feeding on white oak October 9 at Providence, R. I. "Found on sugar maple July 10 at Brunswick, Me. The egg was found July 3 on the red maple at Brunswick, Me." Hatched July 10th. Packard quotes in a footnote from Dr. Dyar: "I have twice found a peculiar variety of *guttivitta*, one at Woods Hole, Mass., one at Jefferson, N. H., in which a large brown dorsal patch was retained in the last stage." Riley reported it in Maryland on oak, hickory, walnut and birch on July 9, 1882. French found it in Union County, Ill., on June 20. The above quotations

go to prove that the insect has never occurred in great abundance at any one period.

Extent of Infestation. According to the writings of Doctor Felt in New York and Professor Sanderson in New Hampshire this pest has apparently been working its way east across northern New York, Vermont and New Hampshire. From thence it has come into Maine. This outbreak was first noticed in 1907. It appeared on the New Hampshire border at Fryeburg, and extended into Androscoggin, Kennebec and Somerset Counties a distance of over 150 miles. In some sections this strip was at least fifty miles wide. Its ravages are confined principally to the ridges of hard wood growth. Whole woodlots of from ten to several hundred acres have been stripped bare of foliage. It has been a serious blow to the maple sugar industry of Maine. In one sugar berth in Sidney the owner reported stripping of the tops of the trees in 1907. The following spring 3,000 trees were tapped. In the summer of 1908 the trees were completely denuded, but put out a second crop of leaves in the fall. The same trees were tapped last spring and allowed to run the same length of time as on the previous season with the result that only about forty per cent. as much syrup was secured. The trees were again partially stripped during the past season. Undoubtedly many of them will not survive the shock.

A fifty-acre woodlot of beech which had been stripped more or less completely for three seasons when examined the past fall showed at least fifty per cent of dead trees.

Orchard Injury. The damage done has not been confined to forest sections, but orchard and shade trees have suffered alike. In many instances whole orchards have been completely stripped of leaves, the fruit standing out on the branches as lone sentinels of the destruction wrought. One orchard that was stripped during the past season was visited on the first of October and the trees were found in full bloom again. Nature was endeavoring to reëstablish the promise of seed time and harvest under very discouraging conditions.

Life History. The life history of this insect is much the same as that of others of the same family, so that it seems unnecessary to go into it in detail. From my notes of 1909 I select the following: "Moths were flying in abundance during the last week of June. Were attracted to light and remained at rest on the house during the day. On June 30th in the orchard of F. H. Morse of Waterford, Oxford County, found many eggs. They were laid singly on the under side of the leaves and a curious fact was noted that but a single egg was found on a leaf, although there were thousands of

moths in that section. The eggs are much flattened and are attached very firmly. About fifty per cent of the eggs were hatched and some few had passed the first molt. The owner was instructed to spray his orchard immediately with lead arsenate, 2 lbs. to 50 gallons, but failed to do so until about three weeks later, at which time it took a double dose of the poison to successfully control the caterpillars.

"On July 27th, 1908, visited the orchard and woodlot of Nathan Sanborn in Cumberland County. Found several hundred acres of beech, oak, etc., stripped, while hundreds of apple trees were bare and the elms and maples about the house were being defoliated. Turkeys, geese and chickens were busily engaged in adding their mite to the exterminating process. A chicken caught by a hawk but released by the hawk being frightened, was dressed off, a post mortem examination revealed seventy-five full grow caterpillars of *H. guttivitta* in its crop. The chicken weighed when dressed only one and one-half pounds.

Associates. Associated with *H. guttivitta,* in many cases in great abundance, were *Anisota virginiensis* and *A. rubicunda*, together with *Symmerista albifrons.*

Enemies. Among the enemies noted were a few birds (I believe the great scarcity of birds during the last few years accounts for the wide devastation by this pest) predaceous bugs, especially *Podisus modestus* and beetles of which *Calosoma calidum* and *C. frigidum* took the leading part, were quite numerous. Hymenopterous parasites were much in evidence, so were Tachinid flies, but the leading controlling factor was the presence of a fungous disease which was so effective that whole colonies were practically wiped out. Our friend, the skunk, was busy in some sections. In one instance where a heavy growth of hard wood was completely stripped, no pupæ could be found, the ground being dug over completely, apparently by skunks and foxes.

Future Outlook. All appearances at the present time point to an early control of this phenomenal outbreak by the above named agents.

Mr. Felt: I just want to call attention to Mr. Hitchings' remark in regard to the absence of insectivorous birds, and to state that we have in New York for the last decade suffered greatly from leaf eating caterpillars, presumably on account of the great scarcity of birds.

I understood Professor Hitchings to give voice to the sentiment that this caterpillar spread from New York and New Hampshire to Maine. It seems to me the insect became unusually abundant over a large

area at once. In other words, it is not a migration, but an unusual development due to favorable climatic conditions or to the absence of natural enemies.

PRESIDENT BRITTON: Doctor Hewitt will now present his paper on the Larch Saw Fly.

THE LARCH SAW FLY (NEMATUS ERICHSONII)

By C. GORDON HEWITT, *Ottawa, Canada*

[Withdrawn for publication elsewhere]

MR. S. J. HUNTER: The speaker, in introducing his remarks, stated that this species was parthanogenetic. I would like to know upon what grounds he bases this statement.

MR. HEWITT: By the simple fact that no males were present, and also from the fact that I have reared larvæ from unimpregnated females.

Afternoon Session, Wednesday, December 29, 1909

Meeting called to order by President Britton at 1.00 p. m.

PRESIDENT BRITTON: The next paper on the programme will be presented by Mr. T. J. Headlee, Manhattan, Kansas.

NOTES ON THE CORN EAR-WORM

By THOMAS J. HEADLEE, *Manhattan, Kan.*[1]

The fact that corn, which is one of the main sources of income to the people of Kansas, has suffered a damage of about 3.5 per cent to each of the last three crops through the ravages of this insect, coupled with the acknowledged fact that no satisfactory method for its control on corn has been devised, has compelled the writer to plan a study of the corn ear-worm for the purpose of finding how it may be controlled. Undertaking the study of this problem was

[1] The writer desires to acknowledge the aid rendered him by his student assistant, Mr. Walker McColloch, who under his immediate direction carried out the details of this study, the practical results of which are recorded in this paper.

rendered still more urgent through the discovery[2] made by our veterinary department that intravenous introduction into horses of certain molds and bacteria found growing on the exrement of the larva in many cases produces symptoms of blind staggers, and that introduction per orem produces well marked cases. As the research has gone forward the writer has become increasingly aware of the magnitude of his task. He has come to see it as one requiring the most fundamental sort of study for its completion. He has no thought of attempting to offer at this time a complete solution for the problem, but hopes merely to set forth briefly a method by means of which this insect's injury to corn may be materially reduced. Only such facts of the corn ear-worm's life history and habits as are necessary to the development of methods of control will be considered in this paper.

A majority of the third brood of larvæ enter the soil and prepare their winter burrows as has been described and illustrated by Quaintance and Brues.[3] The pupæ into which they transform average three and one-half inches below the surface with one and seven inches as extremes. (This average was determined by the examination of 503 pupæ collected from different cornfields about Manhattan during the springs of 1908 and 1909.) Here they remain until June of the following year. Having found the larvæ feeding in great abundance in weed patches and alfalfa fields in the early fall of 1908, the writer fully expected to take the pupæ in such situations. Although last spring a 10′ x 10′ area in a patch of velvet leaf, which in the fall of 1908 was infested with many larvæ of various sizes, and several 5′ x 5′ areas in alfalfa, where in the fall of 1908 the moths deposited their eggs thickly, were selected and carefully examined, nothing could be found. It is probable that parasitic enemies and sharp frosts destroyed the larvæ. The data thus far accumulated indicate that the corn ear-worm hibernates mainly in the soil of infested cornfields. The number of pupæ varies directly as the field examined has been slightly or badly infested, and although more than one half perish before emergence time from one cause or another, enough survive as a rule to infest almost one hundred per cent of the ears of the new crop without outside aid.

The moths begin to emerge in late May and reach maximum emergence in early June. Very soon after fertilization the females deposit

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[2] Dr. F. S. Schœnleber and assistants, chief of whom may be mentioned Mr. Thomas P. Haslam, of the veterinary department, Kansas State Agricultural College, have recently found this to be the case.

[3] 1905, Quaintance and Brues, Bul. No. 50, Bu. of Ent., U. S. Dept. of Agric.

eggs on various useful plants and on weeds, but seem to prefer corn plants to anything else. Indeed, so emphatically is this the case that from the date of emergence to the hardening of the corn, few eggs are laid anywhere else in the vicinity of cornfields. Until silking begins the eggs are placed on the corn blades and the larvæ feed on the tender curl of the corn. After silking commences the eggs are laid almost exclusively on the silk. After the silks dry and shrivel, so long as the stalk, blade and husks remain green, a few eggs are deposited. Gradually all such oviposition ceases and the moths turn their attention to various weeds in and around the cornfields and to adjacent fields of alfalfa. At this time they deposit hundreds of eggs on alfalfa, red clover, velvet leaf, foxtail, bladder ketmia, lamb's quarters, sunflower, soy beans, millet, Amaranthus, sp. and smartweed (*Polygonum, pennsylvanicum*).

CHART NO. I

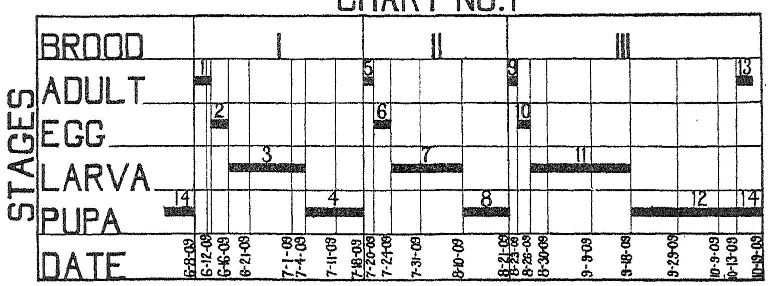

Chart No. 1.—Diagram showing the possible number of broods of corn ear-worm at Manhattan, Kan. 1=pair of first-brood adults from emergence to oviposition; 2=the average of 40 eggs from deposition to hatching; 3=the average of 10 larvæ from hatching to pupation; 4=the average of 9 pupæ from pupation to emergence of adult; 5=pair of second-brood adults from emergence to oviposition; 6=the average of 30 eggs from deposition to hatching; 7=the average of 10 larvæ from hatching to pupation; 8=the average of 10 pupæ from pupation to emergence of adult; 9=pair of third-brood adults from emergence to oviposition; 10=the average of 25 eggs from deposition to hatching; 11=the average of 11 larvæ from hatching to pupation; 12=the average of 9 pupæ from pupation to emergence of adult; 13=pair of fourth-brood adults from emergence to oviposition; 14=that portion of the third brood of pupæ which forms the overwintering brood.

While there is no doubt whatever that the larvæ prefer corn and will be found upon it so long as it is present and sufficiently succulent for food, there is also no doubt that they are able to develop upon a diet of alfalfa, bladder ketmia, velvet leaf and sorghum and are able to finish their growth on many species other than these. From the time the larvæ appear until the corn grows too hard for

their liking they are found elsewhere only occasionally. After the corn ripens they may be found in great numbers in alfalfa, in patches of velvet leaf, on bladder ketmia, and on ground cherry. This fall they were especially abundant in alfalfa.

The possible number of broods was determined in an outdoor screen insectary by getting eggs from the first moths that emerged in the spring which would oviposit in confinement, breeding these through to moths, taking eggs from the first to emerge, and so continuing throughout the season. Chart No. 1 will serve to give a summary of the results.

Examination of this chart shows that the insect experiences three full broods and a partial fourth at Manhattan. The first extends from June 8, 1909, to July 18, 1909, occupying 40 days, under an average mean temperature of 76.1°F. and relative humidity of 78.6°; the second from July 18, 1909, to August 21, 1909, occupying 34 days, under an average mean temperature of 77.6°F. and relative humidity of 77.2°; the third from August 21, 1909, to October 13, 1909, occupying 53 days, under an average mean temperature of 72.8°F. and relative humidity of 67.3°F. The fourth brood is only partial and the young do not reach maturity. Most of the third brood of pupæ do not transform to adults in the fall but remain in the ground as the overwintering brood.

The actual number of broods has been determined by making frequent and regular countings of the number of eggs borne by corn plants of different ages and by observing the prevalence of moths and the age of larvæ in the field. The variation in the number of eggs per corn plant for different counts is not sufficiently pronounced to reveal the presence of very distinct maximums indicating distinct broods until the tremendous increase due to the arrival of the third brood appears. The results of plotting the counts for 1908 and 1909 from field corn and constructing curves are shown in chart No. 2.

The observer experienced difficulty in the field in separating the first brood from the second, and still more in separating the second brood from the third, and after the arrival of the third lost all distinction between the broods. From the time the third brood came on moths could be found in large numbers and eggs and larvæ in all stages at any time. The number of broods as determined by field observations alone is three, but a partial fourth might very well occur as all above-ground stages of the insect may be found until heavy frosts.

Study during 1908 had indicated: (1) that early winter plowing would, as has been stated in the literature of this insect, greatly

reduce the number of such overwintering pupæ as would survive, if undisturbed; (2) that the keeping down of weeds in the cornfields, along fences and over neglected places might prevent those larvæ

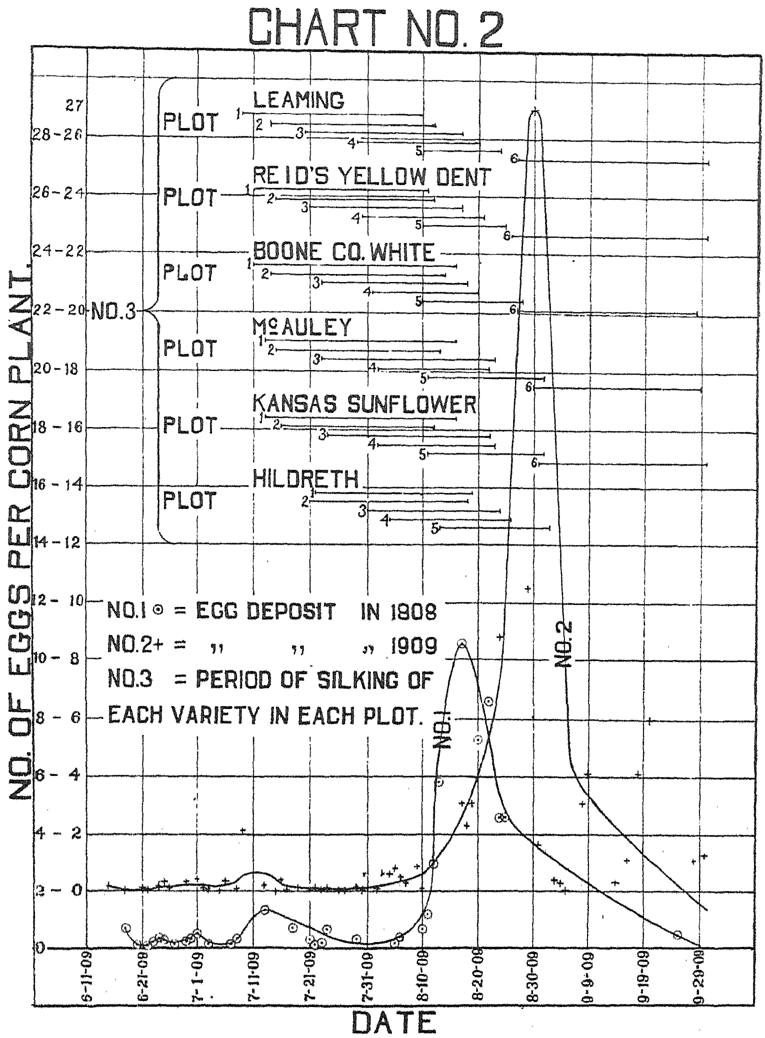

Chart No. 2.—Deposition of eggs on field corn in relation to time of silking of each variety in each plot.

which develop after the corn is ripe from reaching maturity, and that disking the alfalfa in early spring might destroy such as transform to pupæ in alfalfa fields, thus greatly reducing the numbers of the pest; (3) that early planted corn was less injured by the larvæ than

corn planted later and that this difference was probably due to the fact that the early planted corn finished its silking before the third brood came on in full force.

In support of finding No. 1, it may be said that in the spring of 1909 four 10′ x 10′ plots, examined in a field which on September 22 of the preceding fall showed sixty-four per cent of the ears infested and which had been plowed in early winter, gave no living pupæ; while two 16′ x 16′ plots in a field which showed a somewhat larger per cent of infestation the preceding fall and which was undisturbed until spring showed six living pupæ.

In regard to finding No. 2 it may be said that while, as stated earlier in this paper, our examinations indicate that most, if not all, the pupæ of corn ear-worm winter in the soil of infested cornfields, there is no doubt that the presence of weeds in and around the corn enables many belated larvæ to finish their growth. Weeds, therefore, should not be tolerated in such locations. The parasitism of the larvæ infesting weed patches and alfalfa fields, particularly the latter, in the autumns of 1908 and 1909 has been exceedingly high and the early hard frosts have destroyed large numbers. Possibly these agencies may account for the absence of pupæ in such places.

In order to determine the exact relation existing between time of planting and injury and to find out the exact cause of this difference, six standard varieties of corn were planted at different periods. A two and one-half acre plot of ground of uniform character was selected and divided into six plots. In each plot three 150-feet-long rows of each of the six standard varieties of corn were planted. These strains ranged from one hundred and fifteen to one hundred and thirty-five days in time of maturing. They were Leaming, Reid's Yellow Dent, Boone County White, McAuley, Kansas Sun Flower, and Hildreth. The land had previously been in use for wheat breeding. The soil was prepared by spring plowing and working. The corn was cultivated at first deeply, then shallowly, and kept thoroughly clean to the end of the season. The plots were planted as follows: Plot No. 1 April 15th; plot No. 2 May 1st; plot No. 3 May 15th; plot No. 4 June 1st; plot No. 5 June 15th; plot No. 6 July 1st. Except for cold weather in the spring, some wind and hail in July, the season was excellent for corn production until the middle of August when the drought became so severe that the yield of plot No. 6 was practically ruined. Plot No. 1 produced corn on cob at the rate of 39.8 bushels per acre; plot No. 2 46.5 bushels; plot No. 3 49.7 bushels; plot No. 4 46.7 bushels; plot No. 5 26.1 bushels; and plot No. 6 corn hardly worth gathering. Plots No. 3 and No. 4 produced more corn

than plot No. 2 because they experienced less harm from hail and wind. After ripening the corn was gathered into bags, keeping each row separate, and the damage carefully determined. First the average percentage of ears infested in each variety of each plot was determined, then the average percentage of grains destroyed on infested ears of each variety in each plot. The results are graphically represented in charts Nos. 3 and 4.

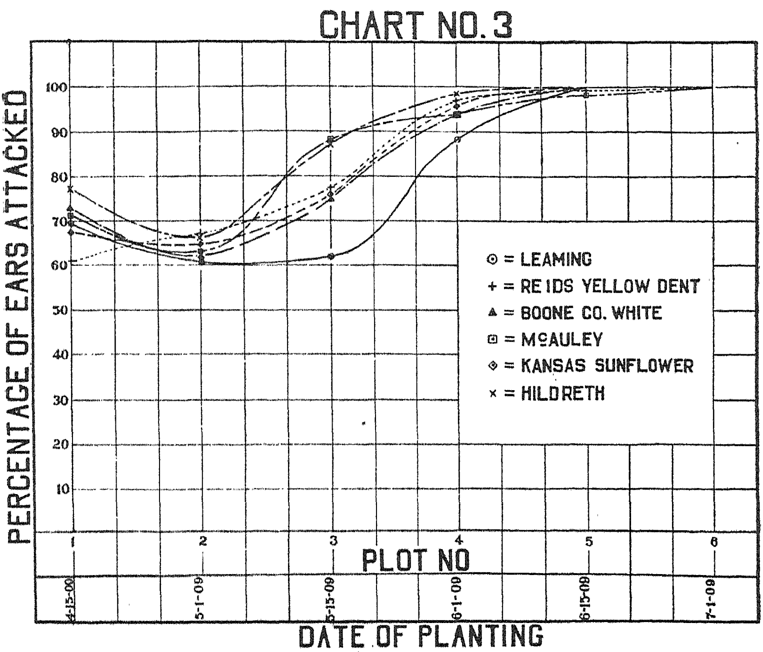

Chart No. 3.—Percentage of ears produced by each variety in each plot infested by one or more larvæ.

Chart No. 3 clearly shows that the corn in plot No. 2, which was planted May 1st, experienced the smallest percentage of infestation, and that the infestation became constantly greater as the time of planting grew later. Chart No. 4, while the curves are very irregular, shows that in general the smallest number of grains destroyed on infested corn was to be found in corn planted May 1st.

Thus it is seen that both the largest number of clean ears and the largest number of sound grains per infested ear were produced in corn planted May 1st.

To be more exact it may be said that corn planted May 1st produced 6.1 per cent more of its total number of ears clean than that planted April 15th, 14.6 per cent more than that planted May 15th, 30.5 per

cent more than that planted June 1st, 35.8 per cent more than that planted June 15th, and 36.2 per cent more than that planted July 1st; and it may also be said that the corn planted May 1st lost 1.3 per cent less grains from ears that were infested than that planted April 15th, 1.2 per cent less than that planted May 15th, 3.1 per cent less than that planted June 1st. The outcome of this experiment

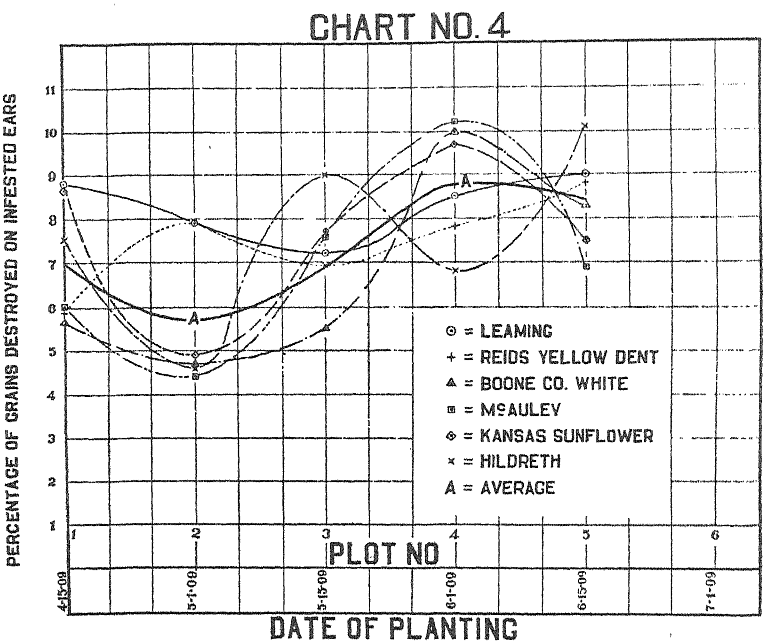

Chart No. 4.—Percentage of grains destroyed on infested ears of each variety in each plot.

indicates that early planting on uninfested or cleaned soil will reduce the corn ear-worm damage about 40 per cent.

Chart No. 2 shows not only the egg laying of the actual broods, but shows this feature in relation to the time of silking of each variety in each plot. It will be noted that plots 1 and 2 finished silking before the third brood of eggs were deposited and reference to charts No. 3 and No. 4 will show that they experienced the least injury. Plot No. 1, with the exception of Hildreth, in which silking came much later than others, remained in silk longer than plot No. 2, thus exposing it for a longer time to oviposition with resulting greater damage. The silking of Hildreth in plot No. 1 is sufficiently later to account for greater injury. Plot No. 1 received a "set-back" from

cold weather which no doubt accounts for its relatively slow growth. In plots No. 3, No. 4, No. 5 and No. 6 the damage is progressively greater as silking comes more and more completely into the time when the third brood is active.

The reason, then, that early planted corn experiences less injury than corn planted later lies in the fact that early planted corn passes through its most attractive stage — silking time — before the third and by far the largest brood has appeared, or at least before it has a chance to do its full work. The experiment further shows that corn planted so early as to get a "set-back" suffers more from this insect than if it were planted just a little later. Clearly the optimum time for planting is just as early as the corn can be put in the ground and escape injury from cold weather.

In summing up the practical results of this study, it may be said that the individual corn grower by planting his crop on uninfested or cleaned soil as early as the season will permit may reasonably expect to escape forty per cent of the injury he would otherwise experience.

PRESIDENT BRITTON: The next paper will be read by Mr. George G. Ainslie, Clemson College, S. C.

NOTES ON APHIS MADIRADICIS

By G. G. AINSLIE, *Clemson College*

[Withdrawn for publication elsewhere.]

PRESIDENT BRITTON: Mr. P. J. Parrott will now present his paper on the Ermine Moths.

THE CHERRY ERMINE MOTH

(*Hyponomeuta padella* L.)

By P. J. PARROTT, *Geneva, N. Y.*

During June, 1909, several cherry seedlings, completely covered with silken webs, were brought to the Entomological Department for examination by Mr. John Maney of the Division of Nursery Inspection. The unfamiliar appearance of the nests and the enclosed caterpillars, coupled with the fact that the specimens were taken from

a plantation of imported nursery stock, led to the conclusion that the insect was a foreign species, and probably an Ermine Moth. Some of the larvæ were kept in breeding cages to obtain some adults which began to make their appearance on July 9. These were compared with descriptions of various authorities, and the insect was identified as the Cherry Ermine Moth (*Hyponomeuta padella* L.), and a statement to that effect was published in the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 2. p. 305. To make certain the identity of the species which we had bred, several specimens of the moths were later sent to Dr. Paul Marchal of the Entomological Station of Paris, who confirmed our identification. This is the first time that the pest has been reported to exist in the United States, and the attention of entomologists is called to the circumstances of its introduction and discovery, and to the economic importance of the Ermine Moths as fruit pests.

General Characters of the Ermine Moths. These moths belong to the genus *Hyponomeuta* of the *Tineina*. There are only a few species but the genus is widely distributed. The moths are small, with an expanse of wings varying from twenty to twenty-five millimeters, according to the species. The anterior wings are snowy-white or greyish, marked with black dots, hence the name Ermine Moths. The hind wings are darker and have long fringes. The classification of the moths is attended with considerable difficulty because of the confusion which has prevailed in the synonymy and the exceeding variableness of the characters which distinguish the species. This is not surprising as the caterpillars and moths of one species resemble like stages of another. The caterpillars of several species have host-plants in common and life histories are very similar.

The caterpillars are gregarious and live within a silken web. The cocoons are spun in close proximity to each other in the nests.

Species Attacking Fruit Trees and Host-Plants. European writers have generally held that there are two common species which live on fruit trees, viz.—*H. malinella* Z. and *H. padella* L. The former is a common pest on apples. It has also been recorded as occurring on the wild service tree (*Sorbus tormenalis*) and Doctor Marchal[1] has reported its presence in destructive numbers on the almond (*Amygdalus communis*). The latter, popularly known as the Cherry Ermine Moth feeds principally on the cultivated plum, blackthorn (*Prunus spinosa*) and hawthorn (*Cratægus oxyacantha*). Other-

[1] Marchal, Paul, Bulletin de la Société d' Etude et de Vulgarisation de la Zoologie Agricole, No. 4, p. 13–26. 1902.

host-plants mentioned by various writers are the cultivated and wild cherry, medlar, apple, *Sorbus aucuparia* and *Fraxinus excelsior*.

The moths of these two species are very similar in appearance and are frequently indistinguishable. Representative specimens of *malinella* have the front wings and the fringe white, while *padella* has the fringe and a portion of the front wings more or less tinted with greyish. Doctor Marchal is of the opinion that *malinella* is a variety of *padella*, which has adapted itself to the apple. Differences are also to be noted in other stages. Rebaté and Bernès[2] state that the caterpillar of *padella* is of a greyish-yellow in color, the cocoons are thin in texture, of a greyish-white color, and are more or less isolated in the nest, while the larva of *malinella* is lighter in color, the cocoons are thicker, and are grouped in clusters.

Other species attacking fruit trees are *H. mahalebella* Gn., which is common on the mahaleb cherry; *H. evonymella* L. (=*padi* Z.) which subsists on the European Bird Cherry (*Prunus padus*) and has been reported as occurring on the cultivated cherry; and *H. irrorella* Hb., which usually feeds on the willow and is said to have attacked cultivated plums.

A Native Species of Ermine Moth. There is one native species, *H. multipunctella* Clem., which according to Chambers[3] is very common in Kentucky. Dyar [4] records the Atlantic States as its range of distribution and Gaumer has obtained specimens of the species in Kansas. The caterpillar feeds on the leaves of *Euonymus atropurpureus* Jacq. and spins its webs over the plant as is characteristic of the insects of this genus. Through the kindness of W. D. Kearfott I have been able to examine specimens of the adults, which differ from the foreign species described by the larger number of black dots on the front wings and the marked difference in the coloration of the hind wings of the sexes. All the wings of the male are white, while the female has the anterior wings white and the posterior wings dark grey.

Economic Importance. The Ermine Moths are regarded abroad as very destructive pests of fruit trees, and because of their importance to horticultural interests, standard European works of reference on orchard insects usually contain a very complete account of these species. Marchal (1) reports that in certain areas of France *malinella* appears almost every year in more or less destructive numbers, and that in some communities where there have been serious outbreaks for successive years, almond trees have been killed. In 1902, *malinella*

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[2] Rebaté, E. and Bernès J., La Chenille Fileuse du Prunier, p. 1–32, 1909.

[3] Chambers, V. T., Can. Ent., Vol. 4, p. 42, 1872.

[4] Dyar, H. G., List of N. A. Lepidoptera, p. 489, 1902.

and *padella* were very abundant and destructive throughout France. The species *mahalebella* is very common on the mahaleb cherry at Fontenay, and during some seasons the wild cherries in the hedgerows were entirely defoliated. During 1897 and 1901, this species was very abundant. Theobald[5] regards *malinella* and *padella* as important pests in England. The former was very troublesome in this country in 1865, 1877 and 1880, and during the first two named years whole orchards were devastated, the foliage being as bare as midwinter. The latter feeds normally on hawthorn, often quite defoliating the hedgerows. Saracomenos[6] says that a large number of fruit trees such as apple, pears and plums which are grown on an extensive scale on the Island of Cyprus are attacked by *malinella* and *padella*. These prove very injurious as they destroy the crops, and if they appear in numbers for a series of years they may cause the death of the trees themselves. The damage occasioned to apple and plum trees is always great. Rebaté and Bernès[2] report that outbreaks of *padella* occur periodically. In 1843 in Lot and Garonne all trees were attacked but in the following year the pest failed to appear. From 1867 to 1871, in 1882 and again in 1888 considerable damage was done by the insect. The outbreak of 1901 was followed by a more severe one in 1902, and it was not till 1904 that the insect was under the control of its natural enemies. During 1908 the caterpillars again increased to destructive numbers, and as was predicted serious depredations occurred during 1909. It is feared that greater damage will be done by these pests during 1910. Other writers comment in like manner on the destructive capacity of these insects.

Life Histories and Habits. The life histories of the different species are very similar. According to Marchal (1) the female *malinella* deposits her eggs during July on small twigs in oval patches about four or five millimeters in diameter. The eggs are covered with a glutinous substance which is at first yellow, but which gradually becomes brown, resembling the color of the bark. In each mass there are from fifty to eighty eggs, which are placed in rows, overlapping one another like tiles on a roof. Hatching takes place during early autumn, but the tiny caterpillars remain sheltered through the winter under the protecting crust of the egg mass. During the following spring the young larvæ abandon their hibernating quarters, and enter the expanding buds, where they assemble in numbers between the sepals of the calyx and petals of the blossom buds or between two

[5] Theobald, F. V., Insect Pests of Fruit, pp. 86–91, 1908.

[6] Saracomenos, D., Cyprus Journal, No. 11, p. 275, 1908.

leaves of the leaf buds. In the early part of May they then burrow into the parenchymatous tissues of the leaves. As many as a dozen of the caterpillars may exist in one colony. The presence of the pest is indicated at this time by the injured leaves turning red in spots. Later abandoning their mines, the larvæ feed openly on the foliage, and spin webs in which they live together in colonies. During the month of June the larger tents are formed, and in severe attacks the tree is stripped of its foliage, and is covered with a sheeting of the dirty, ragged remains of their discolored webs. The cocoons are spun side by side in the nest, in which the larvæ pupate and from which the moths commence to appear in early July. The life history of *padella* differs from that of *malinella* in that the larvæ are not leaf miners.

Distribution of the Cherry Ermine Moth. The Cherry Ermine Moth has only been found in one locality in the State of New York. Eight nests were obtained, and with the exception of a few caterpillars, which were kept in the laboratory to breed adults, the material was destroyed. Repeated examinations failed to find any more evidences of the insect in this plantation, which like all other plantings of foreign stocks, has been under very close supervision this year, because of the discovery during the early spring of nests of the Brown-Tail Moth among these same importations. Present knowledge indicates that the Ermine Moth has not established itself in this state.

Inspection of Foreign Shipments of Nursery Stock. The discovery of this insect is a good example of the importance and value of efficient inspection and of the need of a closer surveillance of foreign shipments of nursery stock. Owing to their destructive character, entomologists should be on the lookout for evidences of the Ermine Moths in nursery plantations, especially of recent importations, as these insects can be introduced in such shipments, and if once established they may prove a serious menace to our nursery and orchard interests.

For the protection of nurseries, inspectors should be on the alert for plants, enclosed with webs, which should be immediately uprooted and destroyed. Spraying with arsenicals has been found in France to be an effective remedy for the treatment of orchards.

PRESIDENT BRITTON: The next paper will be read by Prof. F. L. Washburn, St. Anthony Park, Minn., entitled "Further Observations on the Apple Leaf Hopper (*Empoasca mali*) and Notes on *Papaipema nitela* and *P. cataphracta.*

1. FURTHER OBSERVATIONS ON EMPOASCA MALI; 2. NOTES ON PAPAIPEMA NITELA AND P. CATAPHRACTA

By F. L. Washburn, *St. Anthony Park, Minn.*

FURTHER OBSERVATIONS ON EMPOASCA MALI

In a paper read before the Association last year the following statements were made concerning this insect, as the result of two years' work: (*a*) Fall laid eggs were not found on any herbaceous plant. (*b*) The insect winters only in the egg stage. (*c*) Oviposition in summer was found to occur on the petiole of apple and clover, with the probability of its occurring on other herbaceous plants. (*d*) List of food plants was given. (*e*) Five nymphal stages were reported, covering a period of about twenty-two days. (*f*) Adults may live fourteen days or over; (1907 experiments indicate that they may live thirty days or more). (*g*) The location and appearance of the winter egg blister, and the contained egg was discussed and illustrated. (*h*) Certain observations on remedial measures were given.

This work was done to a very large extent either personally or under the direction of Doctor Franklin, and the work this season has been continued under his supervision. The following data are either new, or confirm the findings of the two previous years.

This species deposits its winter eggs only on perennials, and of perennials, as far as can be determined, only on the apple. One young nymph was found on the willow, and one on plum. In each case these trees were only fifty yards from apple trees, and the nymphs may have been blown to the former trees or carried on larger insects or on the feet of birds. It seems desirable, for the sake of convenience in following the records bearing upon the life history of this insect, to arrange our findings in chronological order, therefore:

June 4th to 10th. At the time when nymphs were found on the apple nymphs were also gathered from the elm, white oak, red oak, gooseberry, black birch, white birch, linden, and reared to adult condition. These were all found to be species other than *E. mali*. Currant bushes, box-elder, mountain ash, dogwood and other perennials were examined carefully during the first two weeks in June, but no nymphs or adults of any species were found. One nymph was found on willow June 11th, and two on plum June 7th. The one on willow and one of those on the plum were reared and proved to be *E. mali.* These have been referred to above, and their occurrence on these trees possibly accounted for.

As proof that no winter eggs are laid on herbaceous plants we cite the results of experiments in which such plants badly infested during the summer and fall of 1908, and still plainly showing the effects of attack, were brought into the insectary and kept in the cold room through the winter. Upon some of these plants living specimens were found as late as October 8th. No individuals, however, survived the winter, nor did nymphs emerge from the tissues in the spring of 1909.

June 4th. No adults on apple trees, but nymphs in all stages. Adults found on alfalfa adjoining apple orchard, but no nymphs, this being a further proof that this insect does not pass the winter in the egg stage on alfalfa. Sweeping this field from time to time resulted in securing the following collections of adults on the dates named: June 4th, 46; June 9th, 91; June 11th, 192; June 14th, 177. On the 12th and 13th there were heavy rains, which may account for the falling off from June 11th. June 21st, 268, one nymph first stage. This is the first appearance of summer broods on herbaceous plants according to our observations. The field which we had been using was then cut, and the following observations were made on a smaller field: June 25th, 275 adults and a few nymphs of the first stage.

July 9th. Nymphs on clover in large numbers, no nymphs on alfalfa.

August 24th. Raspberry leaves badly infested.

August 26th. No egg blisters on apple branches.

September 13th. Egg blisters present on apple trees near clover field in considerable numbers, so numerous that probably egg laying had begun several days previously, yet it would seem that ovipositing was still going on at that date, since these blisters were not so numerous as they were late in the previous fall when egg-laying was over with.

September 17th. Very few nymphs found on alfalfa and clover.

Number of Broods: May 21st eggs hatched in insectary from apple twigs collected by Franklin in the fall of 1908. Since the emergence of these nymphs from the egg blisters may have a possible bearing upon remedial measures, I may be pardoned for taking the time to describe the process. The nymphs emerge from the blisters through the opening made by oviposition, making this opening somewhat larger during the process. We found that if the weather was warm emergence was complete in a few minutes. In one case it took five minutes from the time the vertex of the head appeared until it got completely out of the blister. In another case it took over thirteen minutes. Young hoppers were observed still emerging from egg blisters in large numbers as late as May 26th, at which time the

flower buds on the apple trees were on the point of opening. These observations prove that there is now no question but that the egg blisters so carefully measured by Franklin last fall on the branches of the trees in the apple orchard were those of *E. mali.*

June 4th. First young of the second brood collected on alfalfa.

July 17th. Adults first appeared from the young of June 21st; possibly they were present a few days earlier, for experiments and observations of 1907 and 1908 both show there is an average of twenty-two days in the nymphal stages.

Some of these adults of the second brood were placed on selected box elder seedlings, free from any insect, in lamp chimney breeding cages, for two days. On July 31st the first young appeared. The egg stage at this season of the year varied from seven to thirteen days, nine and one-half days being the average. If we add twenty-two days to this date, the time of hatching the egg, we get August 22d, the date on which the first of the third generation became adult.

Winter egg blisters were not found until fairly láte in September, therefore it would seem that these adults of the third brood lay eggs for a fourth summer generation. Further, the finding of nymphs nearly as late as November 1st, 1908, would also indicate a fourth brood or partial fourth brood in Minnesota.

Economic Work: Doctor Franklin conceived the idea of a hopper dozer to be carried along nursery rows by two men. This hopper dozer consisted of a frame of wood, covered with light canvas, the canvas being covered inside with either crude oil, or some sticky substance. Such a machine was constructed, having a padded cross bar in such a position as to jar the tree, the purpose being to cause the hoppers to fly off and come in contact with the oil or other substance on the inside of the canvas. We found, however, that this bar, which was to serve as a bumper, was too far forward, and caused the tree to bend forward and strike the tree ahead, frightening the leaf hoppers from that tree, and hence nearly nine tenths of the hoppers escaped. Learning from this year's experience we perhaps can remedy these defects, and try the same thing with certain modifications next year. The crude oil which we used was not satisfactory, but the tanglefoot we found to be excellent. We made an imperfect trial of lights, with negative results.

It has also occurred to us that in the spring of the year nursery trees might be sprayed with a resin compound, or some sticky substance in connection with some of the standard solutions used at this time of the year, so coating the branches with a material harmless to the tree and preventing the emergence of the nymphs.

Parasites: We have reared no parasites from *Empoasca mali*.

NOTES ON PAPAIPEMA NITELA AND P. CATAPHRACTA

PAPAIPEMA NITELA: Eggs of this species, figured on page 153 of our Twelfth Report, were laid about September 15th, 1908. A good many hatched on May 24th and 25th, 1909, the hatching being completed May 29th. In all about one hundred caterpillars emerged. They at once showed the leaf-mining habit by making galleries in the leaves of giant bur-elder seedlings, which happened to be in the cage where they hatched, completely riddling the leaves of these plants (see drawings and photos). The caterpillars in their earlier stages moved like Geometrids. On May 28th about eighty-four larvæ from this hatching, which had not had the opportunity to establish themselves in mines, were placed upon selected bur-elder seedlings. According to Doctor Franklin's notes this was done about 5.30 on the above date. At 8 a. m. the next day, May 29th, they had all made quite elaborate galleries in the leaves of these seedlings. On June 2d, after about four days of leaf mining, it was noted that they were working down toward the bases of the leaves, and some had entered the petioles. On June 4th many of the larvæ had bored into the stalks — the tallest plants at that time being about five inches high. On July 7th many of these plants had been killed by the borers, and the larvæ so deprived of their food plants had entered their second plants. At this date host plants No. 2 were about two feet high, and the galleries therein were about four inches long. On July 22d the larvæ were from one to one and a fourth inches long, and the galleries had increased much in extent.

In one plant two caterpillars were found, and in this one the entrance hole of the lower caterpillar was nine inches from the ground, and that of the upper, thirteen inches from the ground, the galleries in each case being above the entrance holes.

On August 17th about all the larvæ which we had reared from eggs had disappeared from the plants. A few of the galleries contained pupæ. Therefore, *P. nitela* larvæ may attack two plants in the course of its life, but evidently never more than two. The first moth reared in captivity from the above material, emerged August 24th (one week earlier than last year), and the last one October 1st. Two seasons' observations indicate that the pupal stage lasts, on an average, twenty-three days.

P. nitela was reared from the following food plants this season: Nicotiani, lamb's quarters, tomato, giant ragweed, cocklebur, peony,

burdock and giant bur-elder, the last plant being, for the two seasons during which this pest was under observation, the worst affected. On August 1st two larvæ of *P. nitela* were found in giant ragweed, with their entrance holes twenty-one inches above the ground, and three other larvæ on the same date were discovered with entrance holes six feet above the ground. On the same date twelve *nitela* larvæ were found in a single giant bur-elder three feet high. Some of these were in the stalk, and some in the branches. In every case the burrow ascended from the entrance hole. On September 3d many empty burrows were found (evidently of both *P. nitela* and *P. cataphracta*) in hemp and other plants, indicating that a large per cent of the larvæ enter the ground to pupate.

P. CATAPHRACTA: On July 14th these were first observed working on young box elders. From this date on they were found to be quite common until nearly August 23d, when the last found larvæ pupated in captivity. Pupation, however, began August 7th, which is about the same date it was observed last year. On August 13th the first moth in captivity emerged.

The food plants as observed in 1909 are as follows: Burdock, box elder, giant bur-elder, hollyhock, cosmos, peony, larkspur, dahlia, thistle, aster, ragweed, tiger lily. It was not found at all in either hemp or golden glow this year. In both 1908 and 1909 it was found most common in burdock. The highest entrance hole in any plant found this year was four feet and two inches from the ground. The burrows did not extend below the lowest hole in any case. I wish to state, however, that from personal observation I do not think it safe to say that they never burrow below the entrance hole, since I believe I have sometimes found the galleries in this position.

Observations on the Migrations of the Larvae in Search of Food Plants: As shown above, the larvæ of one of these species, and probably both, may infest two food plants, and experiments were carried on with a number of nearly or quite full grown larvæ to observe their movements in seeking food. Larvæ were placed in various locations in our experiment garden, and their movements watched for several hours, frequently until they stopped apparently exhausted and finally died without being allowed to enter any food plant. It would seem from these observations, in which we marked carefully the course of each larva, that they seldom if ever travel any considerable distance in a straight line from the place where they first hatch. The caterpillar making the best record in actual distance, traveled in all seventy-nine feet before stopping from exhaustion, but this course was so irregular and tortuous that when it finished

it was only fourteen feet in actual distance from the starting point. Another larva traveled a distance of fifty-six feet before becoming exhausted and at that time was only sixteen and one-half feet from its starting point; a third traveled a total distance of fifty-five feet, and ended twenty-four feet from the starting point, this being the farthest distance reached from the starting point of which we have record. These larvæ were all practically full grown. Occasionally ants appeared to attack the larvæ and cause considerable annoyance.

Plants, the lower part of whose stems were covered with tanglefoot, were completely exempt from injury. It was repeatedly observed in these experiments that when a larva got within a foot or two of a food plant, it had to be constantly turned away from it, since it showed great determination to reach the stems of the desired plant. The two charts shown illustrate the devious routes of two of these larvæ. In one it will be noted that a fairly straight course was taken through plot 46, filled with tomatoes. This was undoubtedly brought about by the fact that although it sought to enter the tomatoes, it was kept away from them constantly, hence the somewhat straight course through that plot. Each plot as shown was four feet square, and the space between the plots was four feet.

The parks about Minneapolis and St. Paul are kept remarkably clean and free from weeds, and several days spent in examining flower beds in these parks resulted in finding that they were almost entirely free from the attacks of stalk borers. When these pests were present they were always found in beds located in a neglected corner of the park near some weedy patch, it being evident in these cases that the larvæ came from the weeds.

Economic Suggestions and Experiments: It is very evident that where flower gardens and their environment can be kept perfectly free from weeds, freedom from attacks of this pest is assured. From our own observation it is clear that it is very desirable to clear up weeds that start during the latter part of May and during June in such places, because at that time any young larvæ which may be mining the leaves of the weeds, will be destroyed with the weeds. Further, it is not probable, from what we have seen in our own experimental garden, that these pests make extensive migrations to other plants. Occasions arise, however, when an owner of a garden cannot control adjoining ground, which may be weedy, in which case it is necessary to find some means of keeping the larvæ out of the garden entirely. Without going into details of the experiments which we have tried this last summer, experiments which called for the planting of very

many plots similar to what are shown on these charts, using such food plants as hemp, peony, dahlia, corn, potatoes, tomatoes, golden glow, asters, tiger lilies, hollyhocks, giant bur-elder, giant ragweed, burdock, daisies, sunflowers, etc., we may say briefly that the most effective barrier found was a thin board smeared with tanglefoot on the outside. This board was about one eighth of an inch thick, and about five inches wide, and placed in the ground edgewise, around the four sides of the plot. The tanglefoot should be put on an inch or so above the ground, so that it could not be easily coated with earth by the spattering occasioned in the event of heavy showers; and whatever sticky substance is used, it should be of such a nature as to either remain sticky, or be kept sticky by several applications, from June 1st to August 1st.

The fact that the larvæ show a strong tendency, when within about two feet of their favorite food plants, to go to said food plants directly, suggests that possibly a barrier of weeds might be placed around a garden, thus providing the caterpillars hatched outside the garden with food, and making it unnecessary for them to travel to the flower beds. These would have to be burned in the fall, of course. They would have to be in position during the last of May, or early part of June.

Parasites: These two species appear to be extensively parasitized, since we have reared many individuals of Tachinids from them. From *P. cataphracta*, *Hypostena variabilis* Coq., and from *P. nitela* also an *Exorista* sp. also *Masicera myoidæa* Desv. in large numbers, the last named being identified by Professor Aldrich. From a breeding cage containing both species we reared what I regard as *Ichneumon lætus*, and evidently *Ichneumon orpheus* Cress. From some material emerging from the pupa of *P. nitela* Professor Aldrich also named for us an Ortalid, *Chætopsis aenæa* Wied.

We have considerably more parasitic material from these two species of at least one genus and parasitic.

Mr. Sanderson: I would like to inquire if the leaf hopper causes serious damage to old apple trees? Does the work of this insect affect the growth of old trees seriously?

Mr. Brues: In regard to the Ortalids, it is well known that the species of at least one genus are parasitic.

Mr. Sanderson: The reason I asked these questions was because some trees in New Hampshire have suffered in the past season from the attack of leaf hoppers.

MR. FELT: I do not know what the conditions are in New Hampshire. Some injury has resulted in New York State, but upon submitting specimens to Mr. Van Duzee they were determined as *Typhlocyba rosæ* Linn.

PRESIDENT BRITTON: The next paper on the programme will be read by Mr. A. G. Hammar, Washington, D. C., entitled "Methods Used in Rearing the Grape Root-Worm (*Fidia viticida* Walsh) and the Codling Moth."

METHODS IN REARING THE GRAPE ROOT-WORM, FIDIA VITICIDA WALSH, AND THE CODLING MOTH, CARPOCAPSA POMONELLA L.

By A. G. HAMMAR, *Bureau of Entomology, North East, Pa., Field Station*

This paper was accompanied by lantern slides showing breeding cages and other devices used in the rearing of the insects, with a summary account of the results obtained with the Grape Root-worm.

[Withdrawn for publication elsewhere.]

PRESIDENT BRITTON: The next paper on the programme will be presented by Mr. W. C. O'Kane, Durham, N. H., entitled "Work on the Apple Maggot."

WORK ON THE APPLE MAGGOT

By W. C. O'KANE, *Durham, N. H.*

In New Hampshire today the most serious orchard pest is the Apple Maggot, *Rhagoletis pomonella*, Walsh.

Four factors contribute to this:

1. The apple is a principal crop in New Hampshire.
2. The infestation is now general throughout the lower two thirds of the state, including the entire apple growing section.
3. While formerly found in early or sweet varieties, usually grown for home use, the insect is now spreading rapidly to the winter fruit, which is the commercial mainstay of the orchardist.
4. No positive, effective and practical remedy is known; at least, none that we may recommend with certainty to the grower who happens to have a careless neighbor, that does not keep his fallen fruit picked up, or to the man whose trees may lie partly along a

stone wall where drops are sure to lodge undetected. Incidentally most orchards in New Hampshire are provided with such walls, varying in thickness from eighteen inches to five feet.

Twenty years ago Professor Harvey in Maine published his monograph of the Apple Maggot. It was a good piece of work. The anatomy and histology of the insect were worked out; the fact was discovered and proved that the egg is inserted beneath the skin of the apple, not laid on the surface; matters of consequence in the life history were determined; and remedial measures were suggested.

Since then Rhode Island has done some work, and the subject has been touched on elsewhere.

No investigation in entomology is ever complete. Matters unthought of, or untouched because they seemed trivial, turn out to be important. The Apple Maggot is no exception. There are gaps in our knowledge of the insect. And it remains still a half-solved problem, which means that, economically, it is not solved at all.

We have undertaken to fill these gaps, so far as we can; and to find the remedy, if it lies in our power to discover it.

To trace the spread of the insect in the state, and to get at certain economic phases of the problem, we are securing from the growers detailed reports of the conditions in their orchards. We furnish them with two printed blanks. One contains a list of seventy-two varieties of apples, and we ask them to indicate those that are badly infested, those moderately infested and those free from attack. The other contains numerous questions. We ask them what their loss has been this year; how long their trees have been infested; how their trees are situated — whether in sod, cultivation or pasture, whether any lie along a stone wall. We want to know if they have ever allowed any sheep in their orchard, any pigs, any chickens, any cows, and — what is equally to the point — what time of year were they turned into the orchard and when removed. We ask them if they keep the fallen fruit picked up, and — again an important point — how often. Other similar questions are included in this blank.

These reports are coming in rapidly, and are both interesting and valuable. Some of the data may be crude and some unreliable, but much is to the point and all is suggestive.

In the matter of life history and habits we are giving particular attention to some eight or ten problems, all of them now more or less obscure. We want to know what becomes of the larvæ in winter apples — for they are there, half grown, as late as December. A lot of these apples are now under observation. Records have been made in various orchards that will form the basis for a study of the flying

powers or wandering habits of the adult female — in other words, the possible danger zone of an infested tree. Later we hope to determine the time that elapses after the female emerges before it is ready to lay eggs, and the feeding habits during this period. This fall we have started on a study of the depth to which the larvæ go to pupate, under various conditions, and the time that elapses after the larva issues from the fruit until it begins to pupate.

Most winter apples in New Hampshire are kept for a while in storage of one kind or another, either in a fruit cellar or under refrigeration. We have secured infested and non-infested apples of the same variety, from the same orchard, and of as nearly identical quality as possible. We have placed these in storage, to observe the deterioration of the one as compared with the other, both during and after storage, and the effect on the vitality and development of the larvæ.

Apparently, in orchards of a hard, winter variety, such trees as are infested will show fruit ripening a little in advance of the rest. We have set ourselves to find out whether this fruit ripens prematurely because of the presence of the larvæ in it, or whether certain trees with a trifle earlier bearing proclivities offer fruit more attractive to the egg laying female. By means of limb cages, and controlled infestation, we hope to accomplish this.

Data are in shape, and plans are now being made, for a thoro tryout of methods of control, on a sufficiently large scale to be conclusive. These will include cultural methods, such as deep plowing; repeated, shallow cultivation; removal of fallen fruit; and the use of livestock, especially hogs, sheep and chickens.

Another plan that will have a thoro trying-out is the use of sweetened arsenicals to poison the adult prior to the beginning of egg laying. The success achieved by Mr. Mally in South Africa this last season, in adapting this remedy to the Fruit Fly, *Ceratitis capitata*, Wied., leads us to hope for good results here. The insects are not the same at all, but their habits are similar.

Finally, in a biological way this insect presents an interesting question of *possible races within a species.* It is a fact that we may have early, infested fruit close to late fruit, with the latter free from attack. Equally is it true that in other cases the late fruit is badly infested. The question then arises: Whether within this species there may not be definite racial limits corresponding to the widely divergent characteristics of early summer apples and of late winter fruit; these limits defined by the inability of a race maturing normally in the one to adapt itself in the next generation to the variety inhabited

by the other race, altho these two races show no structural differences. By isolating fruit with limb cages and making use of artificial infestation we hope to get some interesting lights on this problem. It is of immediate practical value because it means danger or no danger from infested wayside or farmyard trees lying near commercial orchards.

Probably the foregoing will keep us rather well occupied and doubtless other phases will turn up later.

Some of the members of this association have had experience in working out a problem of this type. We should be very glad to receive from these any suggestions as to what to do and what not to do in our work.

Mr. Braucher: What is the best method of protecting fruit from this insect, and how can you tell whether the fruit is infested? My experience has been that there is not much indication of infestation on the outside of the fruit.

Mr. O'Kane: In the case of certain varieties of apple, it is sometimes difficult to determine whether or not fruit is infested with this insect, although it is always possible to do so by critically examining it with a hand lens.

President Britton: Doctor Felt will now present his paper, entitled "Spraying for the Codling Moth."

SPRAYING FOR THE CODLING MOTH

By E. P. Felt, *Albany, N. Y.*

The main purpose of our experiments was to test the relative efficiency of a coarse driving spray, such as that produced by a typical Bordeaux nozzle with a pressure of over 100 pounds, in comparison with the fine misty spray of the Vermorel nozzle and its various modifications.

Comparisons were made between single sprays of each of the above mentioned kinds, applied just after the blossoms fell (plots 1 and 4), between two sprays of each kind, one given just after the blossoms fell and the second just before the sepals closed (plots 2 and 5), and finally between two such sprays and a third applied with a Friend nozzle the last week in July, for the purpose of destroying the second brood of the codling moth (plots 3 and 6).

These experiments were conducted in a young orchard belonging to Mr. W. H. Hart of Arlington, N. Y., near Poughkeepsie, the first

being duplicated in the orchard of Edward VanAlstyne at Kinderhook. The Hart orchard is on a moderately high hill, the trees being thrifty, about fifteen years old, 15 to 18 feet high and 30 feet apart. Each plot consisted of approximately forty-two trees, six trees in a row one way and seven in a row the other way, the central six being the actual experimental trees and invariably Baldwins, though some of the barrier trees were Northern Spys. The experimental trees were carefully selected for uniformity of size, fruitage and infestation. An examination of one resulted in finding thirteen empty codling moth cells and of another, none. These were not in the experimental area. The orchard as a whole had not been sprayed much prior to the past season.

The spraying followed the usual practice of orchardists, the aim being to cover the entire tree and especially to hit the tips of the young apples with the spray. The Bordeaux nozzles were set so as to give a maximum of rather coarse spray which would not break up into fine drops till about six feet from the nozzle. The aim of this application was to drive the poison straight down into the tip of every young apple, the nozzle being held about 18 to 24 inches from the fruit so far as possible, and the pressure being maintained at about 150 pounds. This gave a stiff, penetrating spray which repeatedly passed the stamens and collected in the lower cavity, especially in the first application. Despite the above, it was found practically impossible to fill the lower calyx cavity in all cases, especially was this true during the second spraying after the stamen bars had withered a little. An examination showed that the dried tips of these organs were very likely to become entangled and present a most effective barrier to the passage of the spray. In practice it was found much more difficult to cover a tree thoroughly with the Bordeaux type of nozzle than it was with the much broader and more evenly distributed spray coming from the Vermorel nozzle.

The trees were sprayed with 5¼ pounds of Grasselli's arsenate of lead and 10 pounds of copper sulfate to each 150 gallons of spray, enough lime being added to neutralize the copper sulfate as determined by the Ferro-cyanide test. The first application was made May 20, the second May 31 and the third June 28. Two check trees were left in the immediate vicinity of the experimental plots.

Observations upon the growth and development of the fruit were made at intervals during the season, and on September 13 and 14 the dropped apples were collected and carefully sorted. It was then found that there were from 14.91 per cent to 26.67 per cent of wormy fruit under the experimental trees, while the check trees had 73.91

and 81.02 per cent, respectively, of wormy fruit. The apples were picked October 5 to 7 and the remaining windfalls and all on the trees carefully sorted, and these figures, combined with those obtained earlier in the season, were brought together in the following table.

SUMMARY OF PLOTS

Plot.	Total No. of Fruit.	Clean Fruit.		Wormy Fruit.			
		No.	Per cent.	No.	Per cent.	Range of per cent between trees.	Range in No. between trees.
1.......	30,177	29,818	98.81	359	1.19	.63- 3.16	30-111
2.......	10,316	10,206	98.93	110	1.07	.61- 2.66	6- 30
3.......	9,680	9,582	98.99	98	1.01	.32- 2.64	4- 29
4......	20,313	20,017	98.55	296	1.45	.96- 2.64	36- 80
5.	19,275	19,084	99.01	191	.99	.49- 1.51	15- 61
6.... ..	7,710	7,633	99.	77	1.	.59- 2.74	4- 23
Check.	3,251	2,366	72.73	885	27.27	25.71-33.57	217-668

Bearing in mind that plots 1 to 3 were sprayed with Vermorel nozzles and 4 to 6 with Bordeaux nozzles, as described above, it will be seen that in each of these groups there is a successive decrease in the number of wormy fruit obtained from the various plots. This, while apparently significant, has no bearing upon the problem, since there is a similar decrease in the total number of fruit upon the trees of the various plots. The percentages of clean fruit or the percentages of wormy fruit, it will be seen, are remarkably uniform for each of the six plots, showing that so far as this orchard is concerned under conditions obtaining the past season, there was very little difference between treatment with a coarse driving spray applied at a relatively high pressure and a finer spray which under no conditions could be driven with much force. Furthermore, it is impossible from a study of the percentages, to find any very marked benefit from the second and third applications unless it be in the case of the treatments with the Bordeaux nozzle. Even then the latter only approximate and hardly exceed the results obtained with the Vermorel nozzle. As pointed out before, it was found much more difficult to cover a tree thoroughly with the Bordeaux than with the Vermorel nozzle. Reference to the check trees shows a material benefit accruing from even one application, since the sprayed plots gave at least 98.55 per cent of worm free fruit, while the unsprayed or check trees produced but 72.73 per cent of worm free fruit.

An analysis of the records of individual trees in the various plots summarized in the following table, discloses an interesting condition.

VARIATION IN INDIVIDUAL TREES

Plot.	Maximum Tree.		Minimum Tree.		Range in No. of Wormy Fruit.
	No. Fruit.	Per cent Wormy.	No. Fruit.	Per cent Wormy.	
1	8,745	.63	2,507	3.16	30-111
2	3,649	.75	226	2.66	6- 30
3	2,298	.61	417	2.64	4- 29
4	5,044	.96	3,002	2.64	36- 80
5	5,137	.49	994	1.50	15- 61
6	3,321	.70	767	2.74	4- 23

The maximum tree of a plot invariably produced the lowest or nearly the lowest percentage of wormy fruit, while the reverse was true of the minimum tree. It will be seen that the variation in number of wormy apples on the various trees was not very great, indicating a fairly uniform degree of infestation. Were such to be true we would expect a lower percentage, as shown by the figures for wormy fruit, on the heavily laden trees. A reference to the record of the plots as a whole shows practically no variation in the percentages of wormy fruit between the more and the less productive plots. This may be due in part to the fact that the plots sprayed two and three times yielded less fruit than those receiving one application of poison — the smaller yield offsetting in a measure the benefit derived from the second and third sprayings.

It may be inferred from the above that unusually favoring conditions resulted in this somewhat anomalous showing. The first experiment, that is, a single application with the Bordeaux and the Vermorel nozzles was also tried at Kinderhook under different conditions, since the trees were older and, moreover, were in the vicinity of still older trees. There is every reason for believing that the codling moth was more abundant in this latter orchard than in the first named. Two plots were laid out in the same manner as at Poughkeepsie and thoroughly sprayed. One plot gave an average of 98.96 per cent of worm free fruit and the other of 98.27, while the check trees produced but 73.08 per cent of worm free fruit. Owing to there being no engine available for these latter experiments and the difficulty of maintaining a suitable pressure by hand, the

spraying was not as thorough as that at Poughkeepsie. The result is shown in a slight lowering in the percentage of perfect fruit.

A study of the wormy fruit gives some interesting data, since it was found on plots 1 to 3, that 10% to 18.36% of all the wormy apples were entered at the end, an average of 14% end wormy. Similarly, in the case of plots 4 to 6, the variation was from 9.94% to 12.50% or an average of 11.50% of end wormy apples in the total infested. Comparing these percentages with the 69.37% end wormy of the infested apples on the two check trees, it will be seen that the major proportion of the codling moth larvæ destroyed, must have been killed in or about the blossom end because of the enormous reduction in the sprayed fruit of the number of end wormy apples. There is a slight percentage in this respect in favor of the coarse spray with the Bordeaux nozzles. Duplicate experiments in another orchard at Kinderhook gave 17.51% to 18.9% end wormy fruit on the sprayed trees, while on the check trees there were 37.28% end wormy fruit. It is evident from the above that the spraying results in the marked reduction in the percentage of end wormy fruit, and that this benefit is secured in large measure at least, without regard to the amount of poison driven into the lower calyx cavity.

The results given above would seem to justify, so far as the Hudson River is concerned, the belief that one thorough spraying with a Vermorel nozzle within a week or ten days after the blossoms fall, will result in protecting a very large percentage of the fruit from codling moth injury.

MR. RUMSEY: I have a set of photographs with me showing the final results of a test we made at the West Virginia Agricultural Experiment Station to determine the relative merits of a mist spray and a coarse, high pressure spray for the codling moth. Before passing the pictures I will give some details of the experiment. Fifty-three Ben Davis trees were used in the work. Twenty-four trees were sprayed four times with three pounds of arsenate of lead to fifty gallons of Bordeaux, using a "Vermorel" nozzle with a pressure of about one hundred pounds. The same number of trees were sprayed once with one pound of arsenate of lead to fifty gallons of water, using a "Bordeaux" nozzle, connected to the spray rod by an attachment bent at an angle of 45°, with a pressure of two hundred to two hundred and fifty pounds. The spray was applied just after the petals fell. To the trees which received four sprayings the last spray was applied July 21. Five trees of the same variety were reserved

as checks. Five trees were also selected from each of the different methods of treatment. The fruit from the fifteen trees was examined about every two weeks during the season, beginning with the June drop. A record was made of the wormy apples as to whether the worms entered at the calyx, side or stem of the fruit. While the test was made primarily against the codling moth a record was also kept of the curculio marked apples.

The percentages marked on the photographs are simply those obtained from the picked fruit as seen in the pictures. When we take into consideration the dropped apples from the check trees, the per cent of wormy and curculio marked fruit will be increased as it may also be in the sprayed trees. The average per cent of wormy and curculio marked fruit as seen in the pictures is as follows:

Check trees: per cent wormy, 36; per cent curculio marked, 34.

Mist spray: per cent wormy, 3; per cent curculio marked, 11.

Coarse spray (high pressure): per cent wormy, 2; per cent curculio marked, 11.

Mr. Sanderson: Doctor Felt's results correspond exactly with what I have secured in New Hampshire.

I would like to know what results he got from the use of the Friend nozzle. I wish there was some way of using the word "Vermorel," as applied to the different forms of nozzles, without using the one name. I think we had better refer it to the Committee on Nomenclature, and get a name for the special kinds. It has been suggested that this form of nozzles be called the "Disc" type, which term seems worthy of adoption.

My experience has been that the Friend is superior to the old nozzle. As regards the driving spray: I do believe that the driving spray is superior in that you can get the spray into the tree, and get the fruit treated, which you cannot do with a mist spray.

Mr. Felt: I have the very highest respect for Professor Sanderson's opinions, but I must take a diametrically opposite position. I must say, from my observations, that you will have great difficulty in covering the trees thoroughly with a driving spray.

Mr. Braucher: The first season that I used the Bordeaux nozzle my experience was the same as Doctor Felt's; I was unable to cover the trees thoroughly when using a single nozzle. By using two nozzles the past season with a Y and a 45° crook, having the nozzles set so the two fan-shaped sprays were parallel to each other and to the horizon and at right angle to the extension rod I was able to do very

satisfactory work. When the nozzles are properly set and the coarse spray is used the fans meet about four or five feet from the nozzles and at 200 pounds pressure give a fine driving spray that can be directed downward into the calyx cups and do very satisfactory work.

SECRETARY BURGESS: I would suggest to the members that after they see the spraying demonstration tomorrow, they try an adaptation of the solid stream spray, as I believe it is the coming system for treating apple orchards.

PRESIDENT BRITTON: The next paper will be read by Prof. R. A. Cooley, Bozeman, Mont., entitled "Notes on the Ten-Lined Potato Beetle in Montana."

NOTES ON THE TEN-LINED POTATO BEETLE IN MONTANA

By R. A. COOLEY, *Montana Agricultural College*

During the summer of 1907 and again in 1908 frequent observations were made on the life history of the ten-lined potato beetle in a small patch of potatoes in the home garden at Bozeman, Montana, and the writer became convinced that only one brood of larvæ was produced. The principal points in the life history were followed during both seasons, including the first appearance of the adults, the eggs on potato and on closely related wild plants, the development of the larvæ, their disappearance for pupation and the subsequent appearance of fresh adults. In both seasons the adults disappeared without depositing eggs for a second generation.

It seemed desirable, however, to make cage experiments, and accordingly adults were taken into the insectary on June 19, 1909. Our notes for this season show that the first adult was observed on June 2. On June 7 adults were becoming plentiful and were seen on potatoes in the garden, and on June 13 eggs were being laid plentifully. The beetles taken on June 19 were then clearly of the over-wintered brood. These beetles in the cages laid eggs promptly and plentifully. The first eggs hatched in thirteen days and the larvæ went into the earth on July 13. The first adults appeared on July 30, and after feeding for a few days disappeared into the earth on August 13.

Most of the over-wintered females died after laying a few clusters of eggs, but one individual continued to lay at frequent intervals

up to September 1, when no further attention was given to the cage. This female was alive and laying eggs nineteen days after adults reared from her eggs had gone into the earth for the winter. This female would eat her own eggs when food became scarce, and the larvæ would eat eggs at any time. Observations out of doors carried on during three years show that the beetles had practically all gone into the earth for the winter by August 27. The non-appearance of a second brood of larvæ in Bozeman has thus been noted three years in succession. The elevation of Bozeman in the Gallatin Valley is 4,800 feet; the latitude is about 46°.

We have not made definite observations on the number of generations per year in other parts of Montana, but it seems probable that in the lower valleys of the state where the growing season is longer, the usual two broods will occur.

This beetle is still spreading into new territory in Montana. It has been introduced into Flathead County only during the last few years. Its first appearance in other valleys in the state is still fresh in the memory of residents. On the testimony of early residents it is clearly an introduced species in the Gallatin Valley which is east of the main divide of the Rocky Mountains.

In the Gallatin Valley the species thrives in a wild state on *Solanum triflorum,* which is an abundant weed in unplowed fields. The adults migrate into potato fields from the surrounding native vegetation in great numbers, and in one brood constitute a serious pest.

PRESIDENT BRITTON: I wish to state at this time that it was impossible for Doctor Howard to be present at the meeting, in order to tell us about the parasite work which is being carried on in Massachusetts. The introduction of the parasites and natural enemies of the Gipsy and Brown-Tail Moths is one of the largest experiments of the kind ever attempted. Doctor Howard, however, has authorized Mr. Fiske to make a statement in relation to the progress of the work, and we will now be glad to hear from him.

WORK WITH PARASITES OF THE GIPSY AND BROWN-TAIL MOTHS

By W. F. FISKE, *Bureau of Entomology*

[Withdrawn for publication elsewhere]

President Britton: Mr. John J. Davis, Urbana, Ill., will now present his paper, entitled: "Insect Notes from Illinois for 1909."

INSECT NOTES FROM ILLINOIS FOR 1909

By John J. Davis, *Office of the State Entomologist, Urbana, Ill.*

The following notes are taken from observations by the writer, and, unless otherwise indicated, were made in and about Chicago.

Insects of the Truck Farm and Vegetable Garden

The common asparagus-beetle (*Crioceris asparagi* Linn.) is not very widely distributed, for it is known to occur only in a comparatively small area northwest of the city. Where found, however, it is a pest of great importance every year.

The imported cabbage-worm (*Pontia rapæ* Sch.) was not so generally destructive as in previous years, but in restricted localities, and also in the west-central part of the state, the crop was a total failure because of it.

The cabbage-maggot (*Pegomyia brassicæ* Bouché) is annually a pest of greatest importance; in fact, the growing of early cabbage and cauliflower has been almost entirely discontinued because of it. Midsummer and late cabbage is seldom noticeably injured, nor are the cabbage plants often injured in the seed-bed. Many of the remedies which have been proposed by writers were tried, and only two gave favorable results, these being the tarred felt cards and hellebore decoction, the latter proving the more satisfactory. Applications of commercial fertilizer are of much value.

The cabbage-aphis (*Aphis brassicæ* Linn.) was not so generally destructive this year as in previous years, when it has ruined large acreages of cabbages.

The striped cucumber-beetle (*Diabrotica vittata* Fab.) is seldom a very important pest, and when present it is usually readily controlled by the use of some simple repellant, such as air-slacked lime, dust, land plaster, etc. This year no appreciable injury was done by this insect.

The melon-aphis (*Aphis gossypii* Glov.) has never been destructive to curcubits out-of-doors in the vicinity of Chicago, but in west-central Illinois it is usually one of the most important considerations in the growing of melons. This year, however, it was much less common than in former years. Greenhouse cucumbers, an important product, are often badly injured by the melon-aphis, but where fumigation

with hydrocyanic acid gas or tobacco is practiced, it seldom becomes troublesome.

The squash-bug (*Anasa tristis* DeG.) was found destructive in a few isolated localities, and in every instance the injured vines were near an out-building or other desirable hibernating quarters. More often the injury was to young cucumber plants in cold frames.

The fickle midge (*Sciara inconstans* Fitch) is one of the most destructive hothouse cucumber pests in northern Illinois. The maggots attack the roots and stem of the plant, gnawing the tissue and eating into it. Affected plants may be recognized by a characteristic wilting, and by their slow growth, and unless treated they will soon die. Never have I found appreciable injury except where fresh manure was used. The susceptibility of various varieties is well shown in the photographs. Two varieties, Davis Perfect and a common white spine, were grown in the same range, the cultivation, planting, manuring, etc., being identical. The Davis Perfect, a cross between a white spine and English, was scarcely injured, and had large healthy foliage, while the common white spine was practically ruined. The use of a soaponified creosote preparation, applied at the base of the plant, proved of value, but further experiments should be made with it before it can be recommended as a certain remedy. Nicotine extract and "lemon oil" also proved beneficial. The use of old rather than fresh manure is certainly most commendable.

The greenhouse white-fly (*Aleurodes vaporariorum* West.) and the red spider (*Tetranychus bimaculatus* Harv.) are always pests of cucumbers under glass in this state. As is well known, the former can be controlled by the proper use of hydrocyanic acid gas, but the red spider, after once getting a good start, is not so easily dealt with. Nothing that we have tried has proven satisfactory.

Horse-radish was injured in certain localities by the horse-radish flea-beetle (*Phyllotreta armoraciæ* Koch[1]).

Greenhouse lettuce was badly attacked by the variegated cutworm (*Peridroma saucia* Hbn.), and the European lettuce plant-louse (*Macrosiphum lactucæ* Kalt.?). By poisoning the lettuce leaves and laying them on the bed before setting out the plants, injury by the cutworms was, in most cases, prevented. The plant-lice were easily controlled by the use of tobacco or hydrocyanic acid gas fumigation.

The onion-maggot (*Phorbia cepetorum* Meade), although doing much injury in several places, was not nearly so numerous as in years previous.

[1] Determined by C. A. Hart.

About mid-August, the onion thrips (*Thrips tabaci* Lind.) was very abundant, and did much damage to onions, and especially to the onions for seed. They attacked the seed-pods before the seeds had hardened, and in many places the seed crop was a total failure.

The Colorado potato-beetle (*Leptinotarsa decemlineata* Say) was about as abundant as usual. The apple leaf-hopper (*Empoasca mali* LeB.), which was very destructive to potatoes last year, was a slight offender in 1909.

A new pest of the potato and other crops for this part of the state has made its appearance within the last few years, and this year it has spread over a much larger territory, and has become a pest of prime importance. This insect is one of the wireworms (*Limonius confusus* Lec.[1]), and, according to our observations in Cook County, differs from most wireworms in that it is most abundant and destructive in the higher parts of the infested areas. This species was found damaging potatoes, tomatoes, onions, cabbages, radishes, and sweet-corn. The English soil-fumigant, Apterite, which has been highly recommended by one or two English entomologists, was tried, but without any noticeable benefit.

Insects Injurious to Flowering Plants

The corn root-aphis (*Aphis maidi-radicis* Forbes) was not nearly so destructive to asters as last year, but, nevertheless, injury was reported from a few localities.

In greenhouses, aphids were not especially abundant, except in a few cases. Those which were found doing noticeable damage were *Myzus persicæ* Sulz. on carnations, *Macrosiphum circumflexa* Buck. on easter lily and maidenhair ferns, and *M. sanborni* Gill. and *Aphis rufomaculata* Will. on chrysanthemum.

The variegated cutworm (*Peridroma saucia* Hbn.) was found damaging greenhouse carnations, smilax, and *Asparagus plumosa.* It is especially fond of the tender young asparagus shoots. Our experiments showed the poisoned bran mixture together with the trap lantern a very satisfactory remedy. Hand picking was useless in the asparagus houses.

The greenhouse leaf-tyer (*Phlyctænia ferrugalis* Hbn.) is another greenhouse insect which is with us every year, attacking chrysanthemums. It is of no importance on any other plant. The use of arsenate of lead, beginning when the plants are small, has given us satisfactory results.

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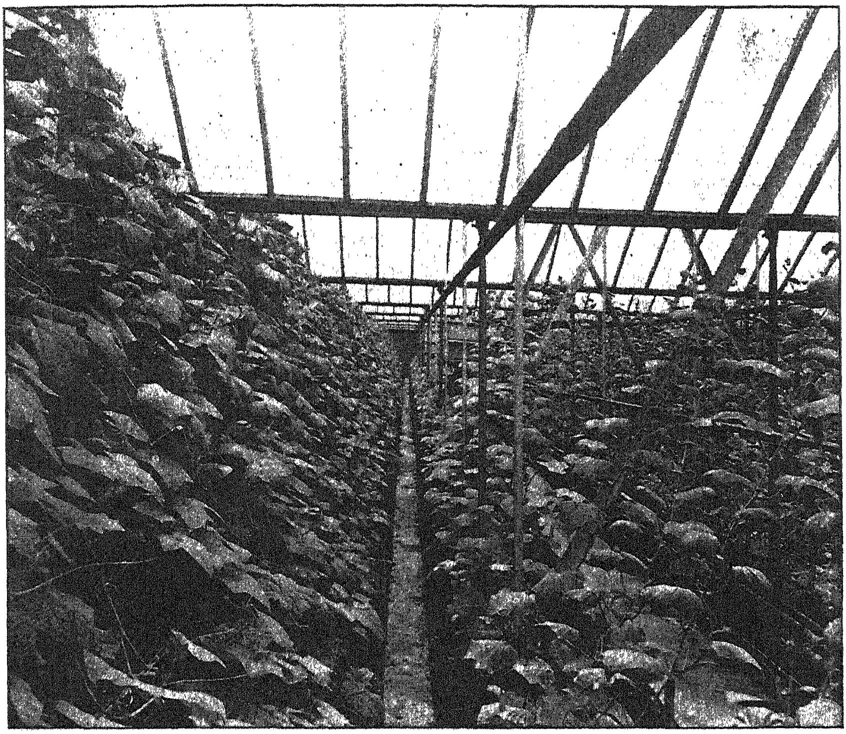
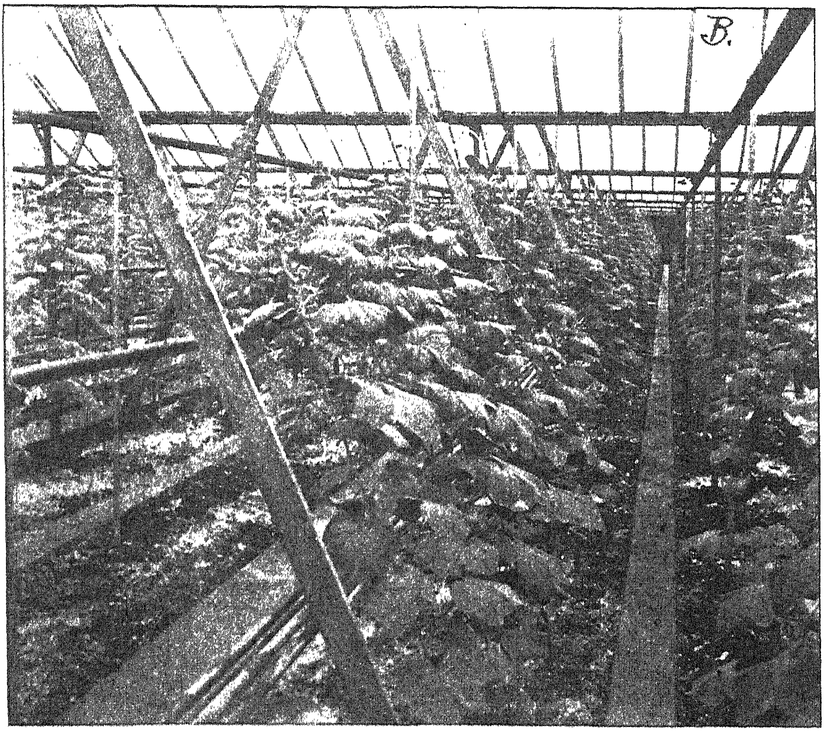
[1] Determined by C. A. Hart.



Cucumbers showing susceptibility to Sciara attack. On the right is the common, white spined variety and on the left Davis perfect

Davis perfect cucumbers showing relative immunity from Sciara attack. Grown in same range as those illustrated on Plate 11



Common, white, spined cucumbers showing injury by Sciara and grown in the same range as those illustrated on Plate 10. Sciara was very abundant in these houses

The southern fern cutworm (*Callopistria floridensis* Guen.) is an insect which has only recently made its appearance as a destructive pest of greenhouse ferns, especially the Boston ferns. It was first reported from Onarga, Ill., in 1907, and since then it has required strict vigilance on the part of the Onarga florist and two other florists in Chicago to keep it from destroying their entire stock. Although only known to occur in these three greenhouses, in Illinois, it is a pest of much importance where found. This species was described in 1852 by Guenée from a single male collected in Florida, and, so far as we have been able to learn, it was not reported again until this year in the Yearbook of the U. S. Department of Agriculture for 1908, where the Bureau of Entomology reports it as a destructive insect on ferns in Washington, D. C., greenhouses. Our experiments show the use of pyrethrum spray late in the afternoon or in the evening, together with the trap lantern, to be the best means of combating them.

The onion thrips (*Thrips tabaci* Lind.) is the most generally destructive pest known to the Illinois florist, roses and carnations being seriously damaged. They are abundant every year, and especially so during the early and late summer months. Nicotine extracts are the most generally used and have given the best satisfaction. Clean cultivation in and around the green houses is of much value. Our experiments show the thrips to be most active on the outside of the buds early in the morning, consequently spraying or fumigating at that time of day is desirable.

The greenhouse thrips (*Heliothrips hæmorrhoidalis* Bouché) is only occasionally injurious. The past year it has been found damaging the Norfolk pine, smilax, and calla lily.

Annually for the past ten or twelve years the rose-midge (*Neocerata rhodophaga* Coq.) has been the cause of thousands of dollars loss to several Chicago rose growers. This insect is not so prevalent now as in former years, because most of the florists who were at one time troubled with it have either discontinued growing roses or have changed the crops grown in previously-infested ranges. In other words, those florists who are now troubled with this pest have been growing roses continuously in those houses originally infested or in nearby houses. Where this species occurs it is the most destructive greenhouse pest known. Hydrocyanic acid gas was thoroughly tried, but it was ineffective against the maggots at a strength which would not kill the plants.

The cabbage plutella (*Plutella maculipennis* Curt.) has made its

appearance as a serious greenhouse pest, attacking stock and sweet alyssum.

Another unusual greenhouse insect, which has recently appeared, is the garden flea-hopper (*Halticus uhleri* Giard). It attacks smilax, the only greenhouse plant found to be appreciably damaged.

An interesting cercopid (*Philaenus spumarius*[1]) was found very abundant on greenhouse rose stock which had recently been imported from Europe. Inasmuch as this species had never been noticed before by us, it is probable that it was imported with the stock. The white frothy masses produced by the nymphs were very conspicuous on the immature rose buds and in the crotches of the more tender branches.

Insects Injuring Shade Trees and Ornamental Shrubs

The bronze birch-borer (*Agrilus anxius* Gory) is found throughout the parks of Chicago, and is doing much damage to the birch trees. It has also been especially destructive in several of the nurseries.

The imported poplar and willow curculio (*Cryptorhynchus lapathi* L.) was first found, several years ago, in the south part of the city. We now have records of the occurrence of this insect in all parts of the city and in several nearby nurseries, where it has been introduced on stock from nurseries in the east. It is a serious pest at present — the most destructive of the many poplar insects — and is continually spreading.

What is supposed to be the linden borer (*Saperda vestita* Say) was found this fall doing much damage in one of the large cemeteries. Only the European lindens were attacked, but all of these, both the permanent plantings and the nursery stock, were dying or dead from its work. Adults have not yet been bred and the identity of the species is uncertain.

The cornus borer (*Oberea tripunctata* Fab.) is found infesting much of the dogwood plantings in the park systems. From a large number of larvae examined last spring 44 per cent were found parasitized with an ichneumonid.

Ranking in importance with the birch and poplar borers is an undetermined ninebark sesiid borer[2] which has proven to be an important pest of ninebark, *Physocarpus opuli-folius,* this shrub being one which is commonly planted in the Chicago parks. The borer usually

[1] Determined by Mr. C. A. Hart.

[2] Since writing the above Mr. C. A. Hart has determined those bred from ninebark and Cornus as *Sesia scitula* Harr. and those from Viburnum as *Sesia pictipes* G. and R.

infests the lower parts of the branches, but in some cases, especially in large branches, they may be found three or four feet above the ground. They burrow in the sapwood, often completely girdling the branch. The same species has been bred by us the past year, from *Cornus* and *Viburnum*.

A leaf-roller (*Exartema permundanum* Clem.) did much damage to *Physocarpus opulifolius* in some of the parks. It hibernates as a larva in folded leaves, and is found in destructive numbers only in those places where the leaves are not raked up and destroyed.

A second leaf-roller (*Olethreutes hemidesma* Zell.[1]) was found quite abundant in some of the nurseries attacking *Spiræa vanhuttei*. The first brood did the most damage, a large per cent of the second brood being parasitized.

Another insect which was conspicuous as an enemy to *Spiræa vanhuttei* is the spiræe sawfly (*Pristiphora bivittata* Nort.[1]) It was common in several nurseries, and in one of them a large acreage of *Spiræa* was kept completely defoliated throughout the year by its ravages. Only in one park was it found, and here only in one clump of shrubbery, thus indicating that it has just been introduced there. I have been unable to find any record of the life history or food habits of this species. The eggs are deposited along the edge of the leaf within the tissue, the insertion of the ovipositor being made at the edge of the leaf between the tissues. The larvæ like other closely related species are voracious feeders. The adult larvæ make their cocoons in the soil just beneath the surface.

The second brood of the white-marked tussock-moth (*Hemerocampa leucostigma* S. & A.) was nearly as destructive as last year, when large numbers of trees in the parks and boulevards of Chicago were defoliated. The tussock-moth is by far the most common and destructive leaf-eating insect in Illinois.

The zebra-caterpillar (*Mamestra picta* Harr.) was found defoliating the cut-leaf elders in one park. It also damaged Tamarix and Hydrangea.

In the parks, and especially along the boulevards, the large webs of the fall web-worm (*Hyphantria cunea* Dru.) were found. They were not abundant enough to be noticeably injurious, but the webs gave the trees a most unsightly appearance.

I have never found the spring canker-worm (*Paleacrita vernata* Peck) common in Chicago, but in the vicinity of Big Rock, fifty miles

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[1] Determined by C. A. Hart.

west, they have been very abundant for the past three years. Many fine old elms have already succumbed to its attacks.

Apatela populi Riley was unusually abundant in all parts of the city, in some cases poplars being defoliated by them.

The red spider (*Tetranychus bimaculatus* Harv.) was not so abundant as last year, but nevertheless it was present in destructive numbers, especially on elm. Not only do the infested leaves become yellow and sickly looking, but they also fall prematurely.

The wooly aphis of the hawthorne (*Schizoneura cratægi* Oestl.) was present, as usual, in very destructive numbers. It is found almost wholly on *Cratægus crus-galli*, and is abundant in all the parks.

The scale insects are of much importance in Chicago, the two most prolific and destructive being the scurfy (*Chionaspis americana* John.) and the oyster-shell (*Lepidosaphes ulmi* L.). Although the San José scale is present in Chicago, it multiplies very slowly, and does not readily spread to nearby trees and shrubs. Inasmuch as the scale is prolific and destructive twenty miles outside of the city, it appears probable that the reasons for its slow growth and spread within the city may be due to one or all of the following: Few birds are to be found in the city, and this lessens its chances of dispersal. The soot and smoke, which is ever present, in combination with moisture, forms acids, and this doubtless kills many individuals or weakens them so that they are unable to survive the winter or it may retard their growth. Further, the shrubs and trees in the city are poorly nourished, and it is known that scale insects are less prolific on such plants.

Mr. Surface: The English sparrow is the chief transgressor in carrying the San José scale in our state, and if it was abundant in Chicago, I would suggest that it might be the chief cause of the trouble.

Mr. Braucher: I am inclined to believe that the slow spread of the scale insects in Chicago is partly due to climatic conditions and to the effect of the lake. In making observations on the time of hatching of the eggs of scale insects including the oyster-shell scale, I found there was several days' difference in the time of hatching of the eggs of the same species whether they were on trees close to the lake shore or whether fifty to one hundred yards back in the park. Where there is such a difference in so short a distance the lake must have a marked effect in checking reproduction and development and consequently the spread of the insect.

Mr. Davis: The San José scale is a very injurious pest near

Chicago, and causes damage in close proximity to the lake, but seldom within the city, so I do not think the climate has much to do with it.

MR. SURFACE: I would like to have one more word as regards the spread of the San José scale. It moves with the wind, and in the orchards the wind should carry it more rapidly. That would be the reason for its spreading more rapidly in orchards and less rapidly in cities; although in the latter it is also disseminated by the English sparrow.

The following papers, owing to the absence of the authors, were read by title:

THE SEASON'S WORK ON ARSENICAL POISONING OF FRUIT TREES

By E. D. BALL, E. G. TITUS and J. E. GREAVES, *Utah Experiment Station, Logan*

As was suggested in a former paper[1] by the senior author, the determination of the effect of arsenical spraying on the life of our fruit trees is a problem of immense importance to the fruit interests of the country. The immediate solution of the problem is, however, of most vital importance to the western fruit growing sections as it is in these sections that the greatest amount of planting is now being done, a planting that would not be justified if the profits of orcharding are likely to be curtailed as has been recently suggested.[2]

It has, therefore, seemed advisable to present at this time a brief, preliminary report of the results of the investigations carried on by the Utah Experiment Station during the season of 1909.

Work of the Season

The season's work consisted of a study of the orchard and soil conditions in all of the principal apple producing sections west of the Rocky Mountains, together with various field and laboratory experiments to determine the effect of different strengths of arsenical compounds and different methods of application on plant growth. The study of western fruit conditions was mainly preliminary in nature and was undertaken with a view of determining the actual extent of the injury and to discover, if possible, the most favorable locations for the inauguration of detailed experiments. The experiments undertaken were also largely preliminary in nature and for the purpose

[1] Ball, Jl. Ec. Ento., 2, p. 143, 1909.
[2] Headden, Jl. Ec. Ento., 2, p. 245, 1909.

of mapping out the problem and determining methods of approach.

No single line of investigation was carried on long enough or thoroughly enough to warrant definite conclusions from this line of evidence alone. The results of the different lines undertaken, however, were in such close agreement with reference to the general principles involved, that taken together the results were very significant and seemed to warrant this preliminary publication.

It might be well to note in this connection that on account of the serious and lasting nature of the pear blight injury to the larger portion of the pear orchards of the inter-mountain region, and the impossibility of separating this injury from that of other causes, that the investigation was confined to the problem as presented in the apple orchards.

A Study of Western Orchard Regions

In the investigation of orchard regions a study was made of the more typical orchard soils especially with reference to their alkali content and general seepage conditions. Two or more of the oldest and longest sprayed of the commercial orchards located in each of the typical orchard regions were usually chosen and thoroughly investigated. On these orchards soil borings were made to ascertain depth of soil and distance to ground water and for chemical analysis. Samples of surface soil were collected to study the deposition of arsenic and samples of the trees taken to study its accumulation in the trees. In each of the orchards, the number of sprayings applied and the amount and kind of poison used were ascertained where possible. These orchards were taken as representatives of the better orchard conditions. In each valley at the same time, an attempt was made to ascertain the places where the greatest losses of trees were taking place and the conditions under which they occurred were investigated. Owing to sickness, the chemical investigations of this part of the work have not been completed and it is impossible at this time to give the detailed statement of the chemical findings.

It is hardly necessary to call attention to the fact that even under the most favorable environment there is an occasional loss of a tree through accident or individual weakness, and that even more frequently trees are permanently injured, especially in the region of the crown, through the ordinary processes of orchard cultivation.

The Pajaro Valley in California is the principal apple shipping section of that state. The soils are deep and range from loamy to heavy adobe. No irrigation water is used and no indication of alkali or of seepage conditions could be found in the principal orchard dis-

trict. The orchard of Mr. C. H. Rogers of Watsonville was chosen for investigation as being the oldest and longest sprayed of the commercial orchards. Spraying has been carried on in this valley for seven years and the average number of sprayings applied has been about four. Nowhere in the valley was evidence seen of injury to the trees of any kind other than accidental.

The Rogue River Valley of southern Oregon has a similar soil and uses very little irrigation water. No traces of alkali were seen except for a very slight spot in the lowest portion of the valley and the scarcity of water prevents the possibility of seepage conditions. The Burrell and Bear Creek orchards are two of the oldest in the Medford district and have been sprayed for a number of years, ever since spraying was undertaken in the valley. No injury could be found on any of the trees in these orchards or in any others examined except for the small alkali spot before mentioned, in which a few young Newtons that had never been sprayed, were dying.

In the Hood River Valley the soil is much lighter, consisting of volcanic ash, and little water is used, the orchardists depending very largely upon the excellence of their soil mulch, as they are compelled to do in the Rogue River Valley. No traces of alkali were seen in this valley and seepage is almost unknown, being confined to small and isolated spots in which the character of the injury is perfectly evident. No injury that could in any way be attributed to the effect of arsenic was found in this valley. Two of the oldest commercial orchards, those of Sears and Porter and of Chriss Dethman, were examined carefully. One had been sprayed for twelve years and the other for considerably longer, both of them heavily, as is the usual manner in Hood River, but without any apparent injury to the trees.

The Wenatchee Valley in Washington is one of the younger orchard valleys, but is already experiencing some trouble. In a number of places trees were seen dying of apparently typical cases of collar rot and often the last tree in the row, where the water had been allowed to stand was found to be dying or dead. They suffered somewhat from sunscald one season several years ago and the injury is still noticeable on many of the older trees, but wherever the trees were found to be dead or dying without showing the sunken area at the base, the evidence of excess of water, together with traces of alkali along the edges of the furrows where the water had stood, was always in evidence and where the collar rot condition was the most prevalent, brownish or whitish margins were present along the irrigation furrows and these areas were quite damp and sticky at the time the writer visited this section. Mr. Z. A. Lanhan's orchard and that of Mr. P.

P. Holcomb are among the oldest of the typical commercial orchards and have been sprayed rather heavily until recently. They do not, however, show as much indication of the trouble as many of the orchards which have been sprayed less and are located under less favorable soil conditions.

The Yakima Valley is located on the Snake River some distance below Wenatchee and like its sister valley has a variety of soils and a considerable amount of hardpan and seepage lands. Mr. William Richards has sprayed his orchard eleven years, six or seven times per year. Gibson Brothers, on similar soil, have been spraying for the same length of time. These orchards are both of them above the danger of seepage and very slight traces of alkali were visible and as far as they were observed, the orchards have not suffered in any way from their spraying. Mr. W. I. Huxtable's orchard which is on the higher lands of Knob Hill, was investigated and a white, impenetrable hardpan was encountered at about four feet, which seemed to be characteristic of the soils of this region. The trees in this section showed no apparent injury but on some of the older orchards the leaves were slightly yellow and the fruit small, indicating a lack of soil fertility. That it could not be due to any effect of the arsenic applied was evident from the fact that the same condition was observed on both apple and peach orchards. At a little lower level than this a large number of young trees just coming into bearing were observed to be dead or dying. Most of the trees affected were Spitzenbergs, and many of them had never been sprayed. In every case, however, the dead trees were found on the lower sides of the orchards where the irrigation water had been allowed to bank up against the roadway or ditch bank. In many of these places the ground showed unmistakable traces of alkali and the condition was apparently growing worse as the newer orchards showed only slight traces of it. It seemed probable that unless more care was used in handling the irrigation water in the future, considerable areas would be injured in this way.

A Ben Davis orchard was seen in this section that had been irrigated very late in the fall and as a result, almost every tree had been winter killed on the southwest side, the injury extending in some cases even to the upper sides of the limbs extending toward the northeast. This was the most severe case of scalding that has been observed and was considered to be caused by arsenical spraying until attention was called to the fact that every single tree was injured on the southwest side.

The Payette-Boise Valleys in Idaho are the largest apple producers and like other Snake River valleys, have considerable amounts

of hardpan at varying depths. These valleys are older than those in the lower Snake River district and the seepage conditions have grown worse from year to year until now large parts of a number of orchards on the lower levels, have been killed by alkaline ground water. On the higher levels the soil shows traces of alkali, but where the drainage is good no injury as yet has appeared on the trees. The orchards of Capt. J. H. Shawhan and of Bower and Hunter near Payette, of Hon. Edgar Wilson at Meridian, and Judge Fremont Woods near Boisé, were studied as typical of the better class of orchard soils in these valleys. These orchards have all been heavily sprayed for a number of years, representing the oldest of the commercial orchards in their districts and those that have received the greatest amount of spraying and yet they showed no sign of any injury attributable to that cause. These orchards all show distinct traces of alkali and it would seem to be a favorable condition for arsenic injury, if such occurs.

In Utah a number of new orchards have been examined in which Ben Davis and Gano trees are dying of collar rot, the greater number of them, however, being cases occurring in family orchards and on town lots where no spraying has ever been done. In Mr. Lars Nording's orchard at Hyrum, five Black Ben Davis trees, planted five years ago, began to die this season. This was the first season that they had borne and only one of them was sprayed, and even at the time that the spray was applied, the characteristic darkened area with oozing sap was seen at the base of the trees.

In the Grande Valley in Colorado a number of orchards pointed out as being typical cases of arsenical poisoning were examined, and in every case except one, unmistakable seep conditions were encountered within five to seven feet of the surface and in some cases even closer. Mr. F. T. Smith's orchard was typical of this class of orchards and in this case a considerable area showed a decided burning of the leaves in the early part of the summer. Mr. Smith reported that upon examination, at that time, he found the soil to be very dry and free from seepage conditions to a depth of six feet. When bored with a nine-foot augur later in the summer, the first six feet were found to be as dry as before but before reaching the seventh foot, the augur sank of its own weight into a soft, sticky ooze that extended as far as the augur would reach. In another place in which a strip had died near one end of an orchard, a soil boring made at the same time, only proceeded a little over two feet before the augur could be pushed clear down to the handle in a material similar to that found before. Mr. M. P. Hickman's orchard which was upon one of the higher mesas

and is claimed by other investigators to be free from alkali troubles, was the only exception to the finding of definite seep conditions and even in this orchard the second and third foot were found to be sandy and very wet and at the eighth foot another layer of wet sand was encountered. Along the edges of this orchard the alkali showing was quite marked and in an oblique strip running through the orchard in which most of the trees had died, some of them with rather typical collar rot conditions, the sides of the irrigation furrows showed unmistakable traces of alkali. It was also noticed that a crop of weeds had sprung up in the area where the trees were affected while the remaining portions of the orchard were quite bare, the cultivation having been the same throughout, indicating that the rising ground water had been sufficient to germinate seeds in the affected areas.

The orchard formerly owned by Dr. F. R. Smith is one of the oldest orchards in this valley and is located on top of one of the fruit ridges. This orchard is twenty-three years old and has received one hundred and eight heavy sprayings, perhaps the greatest amount of arsenic that has been applied to any orchard in this western country. As Doctor Smith relates, he sprayed until the water ran down the trees and saturated the bands, soaking the ground. For five years he used the Kedzie formula double strength and sprayed seven times a season. The orchard shows no indication of having been injured in any way by this excessive amount of spraying. This amount of poison is far more than would be necessary to protect a tree for its entire life under present methods of application. There is no sign of alkali in any part of this orchard, lying as it does on the crest of a narrow ridge, and in this orchard there seems to be the ideal condition for testing the possible effect of arsenic when free from the contaminating influence of alkaline waters, and as yet there is no evidence of injury. In fact, the orchard is in a remarkably healthy condition with the exception of one tree which is subject to overflow from a nearby ditch.

In the Delta-Montrose District a number of orchards which were pointed out as being affected by arsenical poisoning, were studied. Nearly all of the orchards of this section are located upon high mesa lands. The soils on the surface are usually fertile but vary considerably in depth. On boring, the soil augur usually encounters a calcareous hardpan, or "marl" layer, as it is called, at from eighteen inches to three or more feet from the surface. This layer is from one to two feet in thickness and is often penetrated by the roots of the trees. Throughout this entire district the Jonathan apples are more or less affected and in some orchards a considerable number have

died. Mr. L. W. Sweitzer's orchard, near Delta, presents a typical case of this kind. The Jonathans are becoming affected in small groups, while the blocks of Winesap, Gano and Black Twig are apparently uninjured. Upon examining the soil in the places where the Jonathans were dying, it was found that in every case the marl was near the surface in these areas, so near that oftentimes it would be pulled up with the roots of the trees. As has been noted by previous writers[3] when large limbs are sawed off from affected trees, they contime to bleed and deposit large masses of calcareous material. It is possible that the excess of this material in the sap is the cause of the trouble, but whatever it is, the Jonathan seems to be practically the only tree that is affected in this region, the Ganos in this same orchard being very healthy. Located as these orchards are on rather high and well drained mesa land, there is little trouble from alkali or seepage. The Ashenfelter orchard near Montrose is located upon a mesa in which this marly layer is particularly close to the surface and here the condition of the trees suggests a lack of fertility in the soil. This condition was apparent in this particular orchard before it came into bearing, and, therefore, before sprays were applied. This condition has been referred to as systemic arsenical poisoning.

Summary of Orchard Investigations: It will be seen from the above descriptions that in the regions like the Pajaro Valley, the Rogue River and Hood River Valleys, where little or no irrigation water is used, and where if anything the orchards suffer from lack of water, and the soils are comparatively free from alkali, the troubles under consideration are entirely unknown.

That in every district in which the alkali is present in sufficient amounts to appear on the surface and where water is sufficiently abundant to cause seepage in the lower districts, that more or less of these root rot or collar rot conditions occur. In bad cases of seepage whole orchards are stricken within a year or two, oftentimes after they have borne a number of heavy crops. This may be due to a gradual rise of the ground water, or to the gradual extension downward of the roots of the trees. In milder cases, only here and there a tree is affected and these often linger along for a number of years, sometimes in a dry year, partially recovering, only to be stricken again in a wet one. If there is any perceptible slope to the ground the trouble will usually be more marked on the lower end of the irrigation furrows. Where alkali is evidently the cause of the death of the trees, no variety seems to be exempt, all being equally affected.

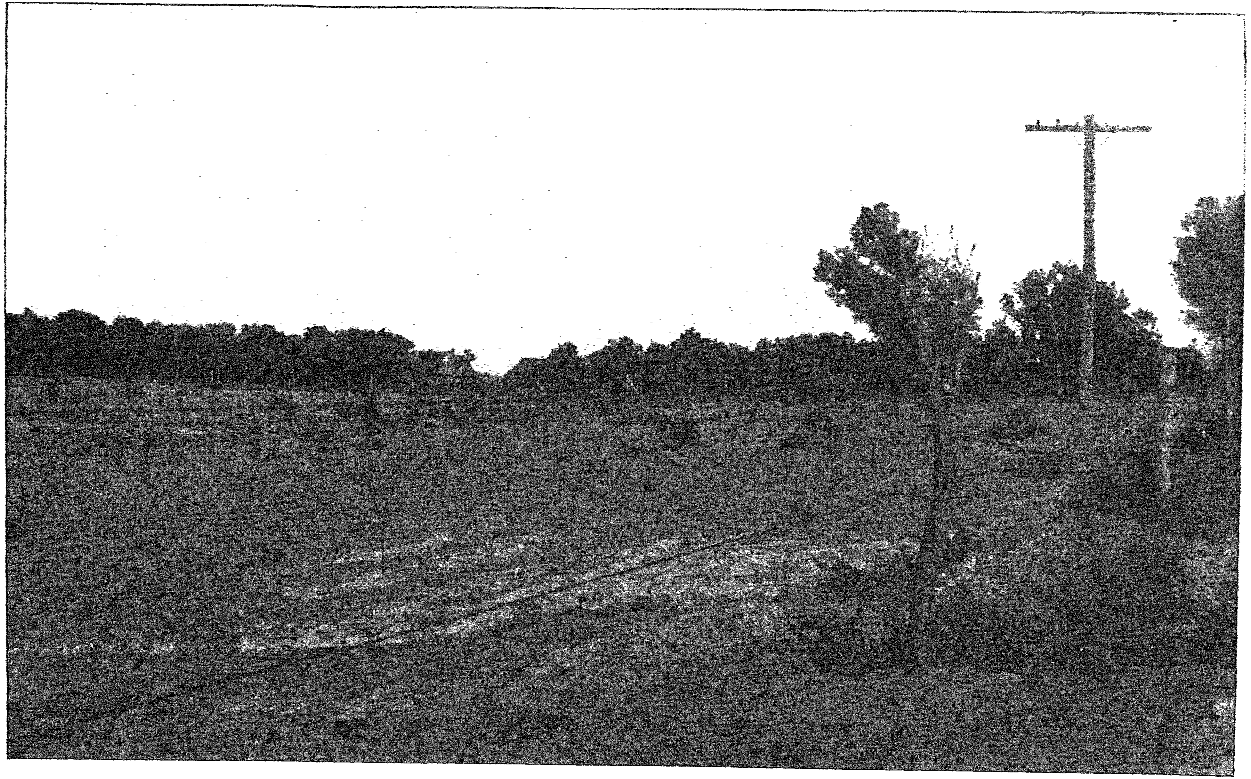
[3] Headden, Col. Exp. Sta. Bull. 131, p. 25, '08.

In a number of the higher valleys of Utah in which there is very little trace of alkali but where oftentimes the ground water is close to the surface, the apple trees of the Ben Davis and Gano varieties suffer from a condition which is commonly known as "collar rot." These trees often linger along for many years, new areas at the crown dying and then gradually healing over as the tree recovers, only to die in a new or larger area at a later date. This trouble seems to be almost exclusively confined to the Ben Davis-Gano type of tree and is occasionally met with throughout most of the apple growing regions. The real cause of this condition is still in doubt. It is usually first noticed just above the surface of the ground as a darkened area of bark which often exudes a few drops of a dark-colored, gummy liquid which later dries, and as the tree grows, this spot becomes a sunken area from which the bark gradually rots away.

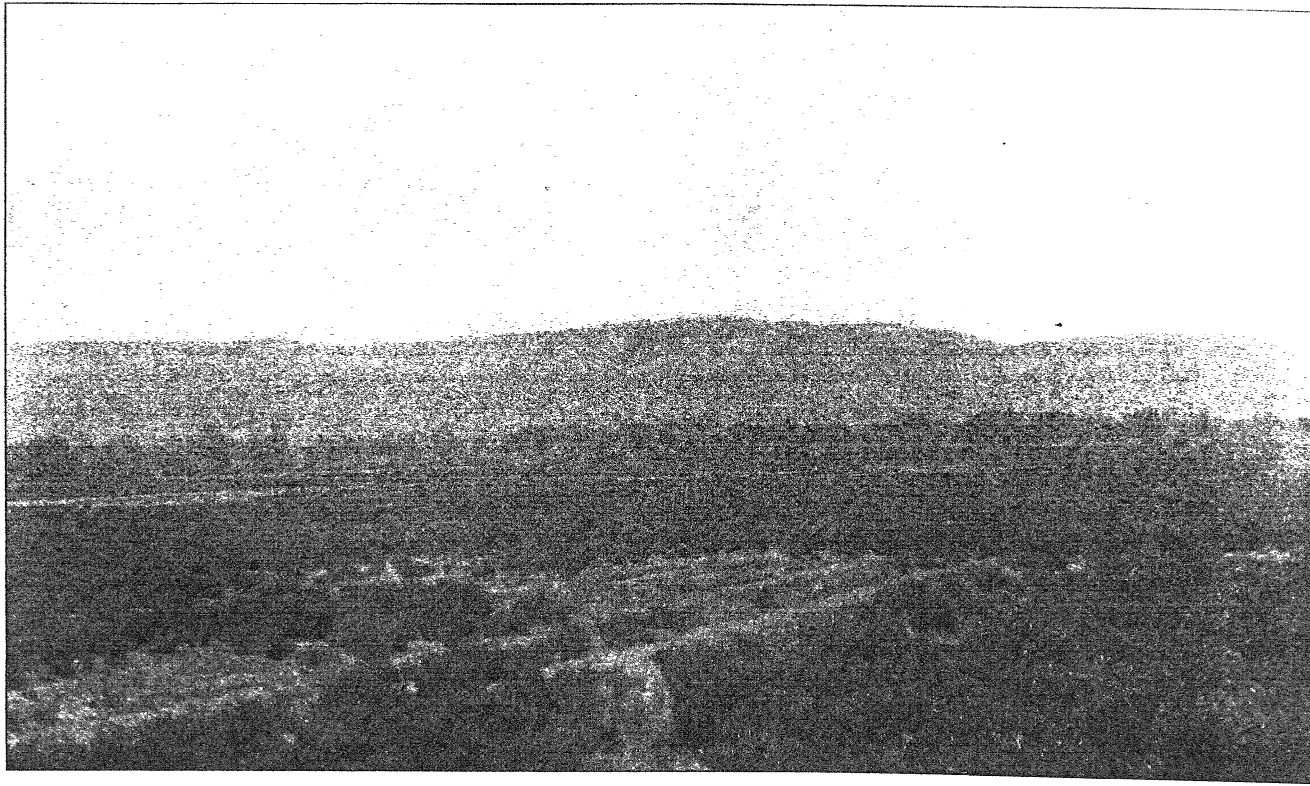
The Grande Valley offers by far the worst case of seepage injury to be found in the western country. As the water has been taken out onto the upper lands, the lower ones have gradually been destroyed by the rising water. Hundreds of acres of orchard have already died and been removed and hundreds more are now more or less affected. Here, as everywhere else, the alkali condition is no respecter of variety or age. Every kind of a tree that occurs in the path of the seepage areas is killed and many young orchards of only one or two years' growth are dying. In fact, during the past season more trees under the bearing age were killed than were those above that age. It has been claimed that the higher regions, especially the mesas, were above the possibility of seepage, but this season has abundantly demonstrated that even these regions are not entirely exempt, as yearling trees on soil which has never grown apples before were killed in considerable numbers by white alkali within a few rods of the top of one of the best fruit ridges, as is shown in an accompanying photograph. With this picture in mind it is easy to see how it would be possible for trees to be killed by seepage on any of the adjoining mesas of similar elevation. There may be, and probably is, a small amount of the collar rot condition as found in Utah, present on some of these higher lands since the Ben Davis and Gano in certain sections seem to suffer more than other varieties. But it seems a rather peculiar logic to reason that these varieties are dying from arsenical poisoning in a valley where Jonathans are scarcely affected, and in the case of the very next valley to account for the death of a large number of Jonathans by arsenical poisoning where Ben Davis and Gano are not affected.

A bad " collar rot " case showing a partial recovery and growing over on one side. Notice the dead bark above and on the left side

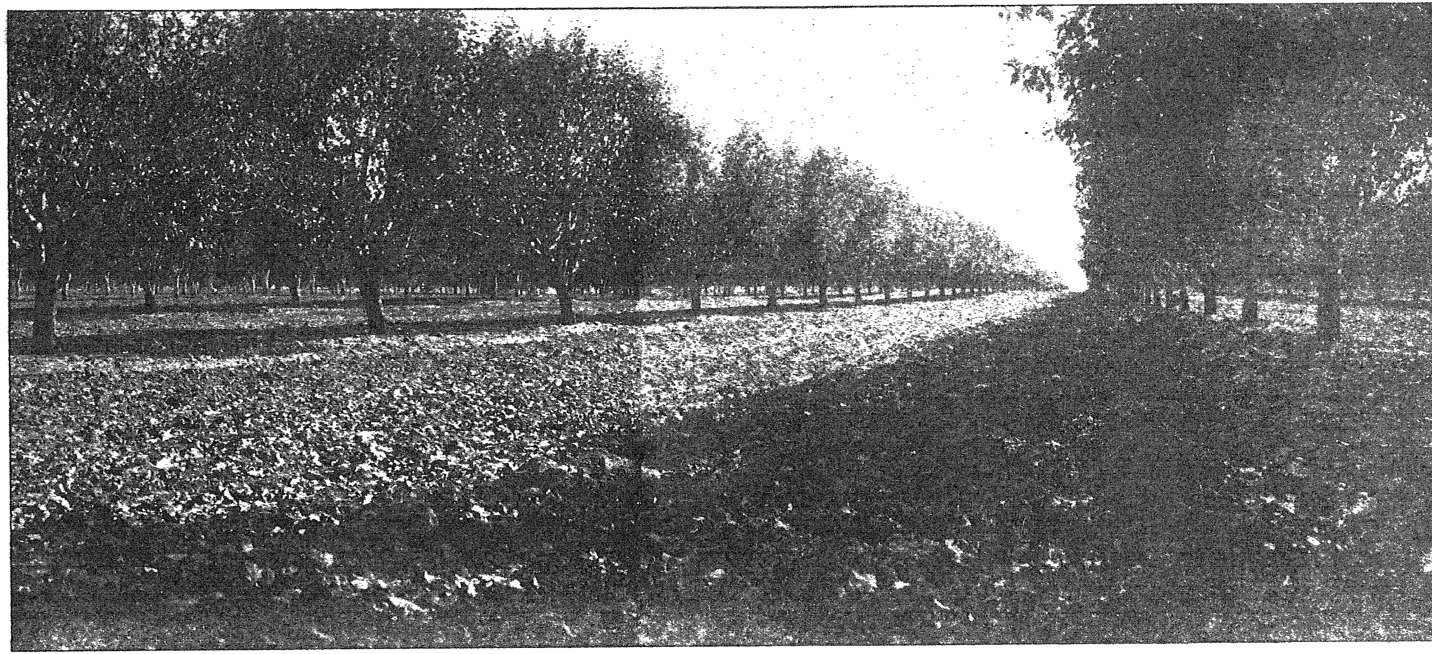
A view in Doctor Smith's orchard. This is one of the oldest in the Grand Valley and has probably received more spray than any other orchard in the west



Alkali killing young trees within a few rods of the top of a fruit ridge. Doctor Smith's orchard in the background



Alkali spots in alfalfa showing the spotted character of the Grand Valley soil



Doctor Miller's orchard at Austin above Delta, a typical mesa orchard and one of the most uniform seen in both stand and growth of trees

Experimental Results

It has been claimed that the greatest injury to the trees from the application of arsenicals was through their corrosive action in destroying the bark at the base of the trees. In order to test this experimentally as well as the possibility of the tree absorbing sufficient free arsenic through its roots to cause systemic poisoning, varying strengths of spraying compounds were applied to different Ben Davis trees. One set of trees received as much lead arsenate as would be required to protect them for ten years; another set for twenty years, and still another set with the amount required to protect trees for forty years. This would be approximately the amount applied to a tree during its entire life, as there are several years in which no sprays are applied at the beginning, and an occasional year in which there is no fruit and therefore no application of spraying material. All of the trees matured their fruit in perfect shape and even in the case of the heaviest application, the leaves were not seriously burned. The material was applied in the form of a spray with sufficient water so that it ran down the limbs and trunk in streams and dripped off from every part of the tree on to the ground to such an extent that, while the tree was whitened, and remained so all summer, the ground under the entire head of the tree was so saturated with the arsenic as to appear mouldy white to a depth of three or four inches. All of this poison was applied at the regular spraying time in the spring and the trees were irrigated in the normal manner during the season. An examination made in the fall disclosed no apparent injury to the bark of the trees at the crown and the roots near the surface had a normal healthy appearance. Part of these applications were made where there were weeds, alfalfa, and strawberries beneath the trees, and even with the heaviest applications no injury was observed upon the vegetation.

It will be necessary, of course, to continue this experiment for a number of years before any definite conclusions can be drawn, but it would seem that if the arsenic in the soil is freed in sufficient quantities from a few years' spraying to seriously injure or kill a tree, that enough arsenic would be freed in one year under like conditions from the excessive amount applied in this case to show some injury.

In order to further test the corrosive action of the arsenical compounds, the various spraying mixtures were applied directly to the bark of medium sized limbs of bearing trees, and maintained in contact with these limbs for a period of forty-five days during the latter part of the growing season. These experiments will be repeated on a much larger scale the coming season and it will, of course, be neces-

sary to study the effect for several years before it will be possible to give positive results.

Each spraying solution was applied in three strengths, double the normal, ten times and twenty times the normal strength. The double strength arsenate of lead produced no effect on the limb. The limbs upon which the two higher strengths of this solution were applied, showed a very slight burning on a few of the leaves soon afterwards, but the injury did not increase through the season.

The Kedzie arsenate showed no injury in any of the three strengths used.

Paris green in double strength showed no injury at all. The ten and twenty times normal strength caused a slight burning along the edges of the leaves.

A soluble arsenate (sodium arsenate) was also applied in three strengths, one-twentieth, the same amount, and twice as much as there would be of insoluble arsenic applied in the form of lead arsenate in a year of normal spraying. The two weaker strengths showed no injury at all. The double strength produced a browning of a few leaves early in the experiment but this did not increase and never became at all serious.

The above summary of the first year's work is, of course, in no sense conclusive but it would seem to indicate that the bark of an apple tree is not seriously affected by the normal spraying solutions even where they remain in contact with it for considerable times. The fact that the weaker strengths of the soluble arsenate produced no apparent injury is also quite suggestive because if the spraying solutions should fall into an alkaline soil at the base of the tree it is not likely that there would be more arsenic set free in a single season than was applied directly to the tree in this case, and therefore, if injury should be produced under the latter condition, some other factor would be necessary to account for the condition, other than the arsenic alone. And as alkali has killed thousands of trees where no arsenical sprays have ever been applied, it would seem natural to infer that the death of the trees, even where both substances were present, might be due, in a large measure at least, to the alkaline factor.

A number of other experiments have been carried on, such as growing various crops in soil taken from around the base of trees said to have died from arsenical poisoning; growing crops in soils in which large amounts of the different spraying solutions have been mixed, etc. Up to the present time, all of the results tend to confirm the conclusions drawn in the cases cited above.

The chemical examination of the orchard soils and of the trees for alkali and arsenic have not been completed, but the results so far are almost uniform in showing very small amounts of arsenic in the trees, from soils that are low in alkali, while all examinations so far in which a comparatively large amount of arsenic was found in the trees, have been from localities in which the alkali was so abundant in the soil as to be in itself a menace to orcharding.

Conclusion

While no definite conclusions can be drawn from these preliminary investigations as has already been suggested, it would appear that the injury to the apple trees in the western country may have a number of different causes. The evidence that alkaline seepage alone is sufficient to cause the death of fruit trees seems to be conclusive. The fact that the only places in which Jonathan trees are found to be dying in any numbers, where other trees similarly situated are not, are on areas underlaid with marl, suggests very strongly that there is some relation between that condition and the death of this variety of trees. The loss of a number of trees that have not been sprayed, in different sections where the alkali is apparently not present in sufficient quantities to be the killing agent, and the further fact that only the Ben Davis-Gano type are killed under such circumstances, indicates that we have a further factor to be considered, which we are at present calling "collar rot." That free arsenic if present in sufficient quantity will kill fruit trees has never been questioned, but the fact that all over the country the orchards which are located on suitable soils free from the other conditions mentioned, are showing no injury even where heavily sprayed for long periods of time, would seem to warrant the conclusion that has been previously stated by the senior author, that arsenical poisoning cannot be the primary cause of the death of the greater portions of our fruit trees. That where alkali is present in any quantity it is probable that the arsenic of the spraying solutions will be set free and will assist in the injury to the trees, but the question whether the alkali would be strong enough in this case to destroy the orchard within a few years without the other factor, is a problem yet to be solved.

NOTES ON "CIGARETTE BEETLE"

By P. H. Hertzog, *Lewisburg, Pa.*

Perhaps the name cigarette beetle carries a wrong meaning to the average tobacco dealer and layman, as the name may suggest that the insect is associated only with cigarettes. Hence some tobacco dealers pay very little attention to it, inasmuch as they have no cigarettes. But since leaf tobacco suffers the greatest loss, it would be more appropriate to call it "tobacco beetle."

Although the insect has been found feeding in various drugs and food, the fact remains that in this country, it is most conspicuous on account of the great injury and destruction to all forms of cured tobacco, such as leaf tobacco as well as manufactured tobacco in the shape of plug, snuff, cigarettes and cigars.

The beetle is less than one tenth of an inch long. Its color is brown and on that account it is not readily seen while on tobacco. The injury is mostly done by the larvæ which are worm-like grubs. But also adult beetles harm tobacco by eating their way out, thus leaving a hole about the size of a pin head. In case of cigars the eggs are usually wrapped in along with the tobacco while the cigars are being made. The egg then hatches in about ten days. Then the young larvæ eat through the tobacco including the wrapper. They often follow the veins of the leaf. One grub may thus make a number of perforations in its meandering course.

Several packers have declared to the writer that the insects can tell the difference between a good and an inferior quality of tobacco, and that they invariably choose to work in a good quality, such as expensive wrappers. Of course, this must be considered as a matter of chance and then, too, their work is sooner discovered in such tobacco.

The tobacco dealer has to consider it as a serious pest, however. Its presence in his establishment may mean thousands of dollars' loss and in addition may injure his trade, which is, perhaps, even a greater loss. Therefore, it is to his interest as well as to the tobacco industry that his place and other houses nearby should be as free from the pest as possible. It must be remembered that the beetle is a most rapid breeder under favorable circumstances, and that it is found in all states in the Union, wherever tobacco is handled or stored. During the past summer it was unusually abundant. The Bureau of Entomology of Washington, D. C., has received more inquiries this season from various sections than it has for some time. The above bureau

has taken steps to gather more definite statistics as to the extent of damage and distribution. In buildings heated during the winter, and in warm climates, it may breed the entire year. In a cold building they are inactive. In the latitude of Pennsylvania there are two broods running into each other, but the adult beetles are most abundant during the middle of June and again the middle of September.

The real proposition and question is how to get rid of it. A small quantity of tobacco may be readily and satisfactorily fumigated. But a large warehouse full is a different proposition. Especially so when the house is not of a very tight nature or when the cases are stored four or five rows deep and three or four layers on top of each other. Under such conditions it is impossible to fumigate successfully, since the gas could not readily reach the interior and lowermost cases. A packer will ask, will not the gas deteriorate the tobacco by bleaching it or imparting an odor? Will fumigation really kill the insects? During my summer's work, it was necessary in each instance to try a few cases in a sample room to show the merits of the work. In each instance the owners were pleased. As to the success of fumigation with hydrocyanic acid gas for the cigarette beetle, entomologists are somewhat divided, yet most see in it the most practicable remedy. This paper is based on the result of its use. It must be remembered that tobacco is one of the most difficult products to fumigate because the leaves pressed tightly against each other and the whole mass packed and pressed into the case forms an almost impenetrable mass. Fortunately most of the insects are on the outer portions of the case and especially at the butt end of the tied hands or bundles. It is there that they can gain the best entrance both into the case and into the tobacco. Most of the injury is done from the butt end in for about ten inches. The interior of the case, where the leaves are the most valuable, is usually free from insects. They eat inwards along and even through the ribs, piercing the leafy part at random. The gas may follow them in their channels. However, in order to do so a large amount of gas is necessary and a long time is required for it to penetrate.

Hydrocyanic acid gas gave most excellent results this summer. Yet it was by no means perfect. The ordinary directions and precautions for fumigating were followed. The formula per 1,000 cu. ft. of room space was 12 ounces of potassium cyanide, 20 ounces of sulphuric acid (liquid measure) and 40 ounces of water. The building is in very good condition, being as nearly gas tight as is to be expected. The gas was allowed to act over twenty-four hours. There was a two-foot aisle between the cases, but they were three cases high. The

lower row rested on scantling. Each case was opened by loosening the middle board at each end, that is, along the aisles, which end, fortunately, was the butt end. We think that such an arrangement and the opening of cases is very important for successful fumigation.

The first fumigation took place on July 10th. The bulk of the first brood had matured by this date. The beetles were numerous and active, flying about the room, collecting at the windows, crawling over the cases and laying eggs on the tobacco. A great many had died a natural death before, since many dead ones were found on the window sills and floor. No doubt many of these had previously laid their eggs. Probably the building should have been fumigated two weeks before so as to prevent egg laying. The gas killed practically all adults, pupæ, and larvæ. Although a few in each stage were found alive in protected places in the interior of cases, but only a few. A few adults were found at the windows immediately after ventilating the rooms. These no doubt were stragglers who had left the building and returned again or they may have come from some other house. The windows from now on were kept closed to keep outside beetles out. Fly paper was used liberally on the window sills and window sashes to catch stray beetles, who were usually attracted to the light. This proved to be useful. The most important floor was fumigated four weeks after the first fumigation. The entire building was fumigated to catch the second brood during the second week in September. After this last fumigation there was relief from the pest. Workmen say they have not seen any adults since. However, at this writing (December), a few larvæ have been found after careful searching.

Let us now see the fate of another house which was not fumigated. During the middle of September the second brood was at its height. Beetles were evident by great numbers crawling over cases of tobacco, in tobacco, at the windows and flying about wholesale. They were most active about dusk. Although this house was not fumigated they fought the insects with great vigor, using some novel methods, which helped much to keep the pest down. As has been mentioned before, the beetles are most active during the evening and since they are attracted by light, advantage was taken of these factors. A number of frames were arranged and lined with fly paper, placing a light in the middle, for the night, to attract the beetles. This was kept up during the bad season. Fly paper was tacked against cases and freely suspended from beams. The papers were changed as soon as they were covered with insects.

Another method that deserves attention is that of a suction arrangement. An electric motor was fastened to a force suction

machine. A large funnel from two to six feet in diameter was attached to the suction machine by means of a hose. The machine contained a fan or bellows which was run by the motor. Lights were fastened to the rim of the funnel. When the current was started, the fan caused a strong suction, drawing in dust and insects from the funnel end, while the insects were blown out at the other end into a screen cage, which was attached to the receiving end. The size of the funnel depends on the power of the motor. The funnel may be shifted to cover more space. The entire apparatus may be mounted on a truck and moved by one man while another man shifts the funnel while the apparatus is moved along a row of cases. A funnel six feet in diameter, with sufficient power, will draw insects into it over an area of twelve to fifteen feet. By this method two persons have gathered over a pint of beetles in a single night. The method no doubt is a great help in keeping the numbers down, but it does not get at the root. It gives many beetles a chance to mate and lay eggs before they are captured. It is not thorough enough and only a part can be partly treated at a time. It may also be added that it is rather an expensive process, especially when electric lights are used. The method was used because the proprietors feared that fumigation would deteriorate the quality of tobacco. Comparing the above and fumigation, we must say that the results are decidedly conspicuous and in favor of fumigation. Although the latter costs more, it is very much more satisfactory. In the fumigated house practically no beetles were evident after the middle of September, while the other house was full of beetles until cold weather set in. The tobacco was also full of worms or larvæ.

One packer had intended to keep his tobacco at a low temperature of about 40°F. Since the larvæ are dormant in cold weather, it was thought that they could be starved. In order to do this it would have been necessary to equip the building with ammonia pipes. But when a contractor stated it would cost about $15,000 to $20,000 to simply install the plant, not counting running expenses, the plan was abandoned, especially so because the plan would have only been an experiment.

Steaming tobacco in the sweat room is sufficient to kill the pest in all stages. It ought to be kept in the room for two or three weeks at a temperature of about 120° to 140°F. Tobacco thus treated is free from the pest until reinfested. If the egg is not killed outright, its hatching is hastened and the young larva is then readily killed. Eggs normally hatch in about ten days. Unfortunately if tobacco is thus treated it may become reinfested during summer, the eggs

being laid by stray beetles, if the tobacco is exposed during the manufacture of cigars. In order to guard against this, cigars before leaving the factory should be fumigated thoroughly in a small room with H C N, then aired and packed. This would not cost much but it would practically insure the manufacturer's business.

The writer knows several parties, who turn out cigars that are free from the pest, although the tobacco was formerly infested. But by steaming the tobacco the pest was killed and then the tobacco is manufactured in a different town where there are no insects to reinfest.

If a single beneficial suggestion has been given or if the paper will induce some one to rid their house of the cigarette beetle by means of H C N, or otherwise, the writer feels that the paper has not been in vain.

For a fuller account of the cigarette beetle the reader is advised to consult Farmers' Bulletin No. 120 of the U. S. Department of Agriculture.

STUDIES OF THE DEVELOPMENT OF EUPELMUS ALLYNII FRENCH AND STICTONOTUS ISOSOMATUS RILEY

By E. O. G. Kelly, *Bureau of Entomology*

These two valuable parasites have been known to science and entomologists for about twenty-eight years. In 1881 and 1882, Prof. G. H. French reared adults of what is known as *Eupelmus allynii* from wheat straw and described the insect as *Isosoma allynii*. Professor French and Dr. C. V. Riley discovered that the insect was parasitic on *Isosoma grande* and that it did not belong to the genus *Isosoma*. Doctor Riley decided that the species belonged to the genus *Eupelmus* and it still remains *Eupelmus allynii*.

During this same winter of 1882, Doctor Riley reared and described adults of *Stictonotus isosomatis* parasitic on *Isosoma grande*.

Doctor Riley, Doctor Forbes, Professor French, Professor Webster and many other students of insects affecting cereal and forage crops have reared these parasites from the straw; and considerable has been written regarding their economic importance, but the larval habits have not heretofore been described.

The females of these two species have rather long pointed ovipositors with which they readily pierce the hard straw containing *Isosoma* sp., and puparium of the Hessian fly. The females put their

eggs into the cells of *Isosoma* larvæ, but not always on the larva itself; and inside the puparium of the Hessian fly, but, again, not into the larva.

Life History. During the early fall the egg hatches in three to six days, after deposition the tiny larva attaches itself to the host larva and sucks its life blood; they do not consume the skin of the host. The larvæ reach maturity in six to fifteen days and pupate in the *Isosoma* cell within the straw, and within the puparium of the Hessian fly. The pupæ are naked in both species. The pupal period ranges from seven to twelve days.

Eupelmus allynii hibernates in both the larval and pupal stages. *Stictonotus isosomatus* hibernates as pupa. Both species are found in cells of *Isosoma* sp. and in pupariæ of Hessian fly at this date (November 26, 1909). There were two distinct broods this year — one in early summer, the other in fall.

Descriptions. The eggs of the two species are quite different; that of *Eupelmus* is whitish in color and pedicellate. The bulb is elliptical in form, about .25 mm. in length and .12 mm. in width; the pedicel is slender, of uniform diameter and nearly as long as the bulb. The egg of *Stictonotus* is whitish in color, elliptical in form and about .3 mm. long and .12 mm. in width.

The larvæ of the two species, though quite similar when viewed without the aid of a magnifier, magnified they present some striking differences. *Eupelmus* larvæ have four distinct rows of bristles on the body, each segment having two dorsal and two ventral; the head bears two tiny brown mandibles; they vary in size from 2 to 4 mm. in length. *Stictonotus* larvæ are more cylindrical, have no bristles and no mandibles; they are 2 to 4 mm. in length. Both species are yellowish white in color.

The pupæ are quite different, *Eupelmus* being black with light rings on the abdomen, while *Stictonotus* has a dark thorax and yellowish abdomen.

A very interesting feature of parasitism presented itself while these studies were in progress. *Eupelmus allynii* larvæ were found attached to pupæ of *Stictonotus isosomatis* and reared to adult; and *Stictonotus isosomatis* larvæ WERE FOUND ATTACHED to pupæ of *Eupelmus allynii* and reared to adult. Parasitic larvæ were found attached to parasitic larvæ whose identity could not be determined because of mutilation or because of the desire of the writer to rear the secondary parasite. However, both species were reared from these larvæ, the host not being determined. In several instances tertiary parasites were found but failed to mature.

Some undetermined secondary parasites were reared from the larvæ of both *Eupelmus and Stictonotus.*

The writer is indebted to Mr. T. H. Parks, agent and expert, in the Bureau of Entomology, for his kind assistance in collecting and rearing these parasites.

COLLEMBOLA AS INJURIOUS INSECTS

By Walter E. Collinge, M. Sc., F. L. S., F. E. S., *Berkhamsted, England*

In a communication read at the Oxford Meeting of the Association of Economic Biologists[1] I drew attention to the part that various species of Collembola play as injurious insects and instanced many cases reported by Carpenter,[2] Curtis,[3] Ormerod,[4] Murray,[5] Guthrie,[6] myself,[7] and others, where they were the direct cause of damage to roots and seeds of healthy plants, and I incidentally pointed out, in referring to the nature of the injury, that they also play an important part in exposing different plants to the attacks of fungi by the injury they cause in wounding their surfaces.

Since then two facts have come to light which have an important bearing upon the subject.

The experiment I made I described as follows:

"During the past twelve months very careful observations have been made upon a series of common species which have fully established the fact that to orchards, numerous bulbs, beans and peas, the Collembola are distinctly injurious.

"The method adopted has been as follows:

"Shallow boxes, containing about four inches of moist soil, have been used, and into these perfectly healthy bulbs and beans have been placed. Into each box examples of different species of Collembola have been placed. The tops of the boxes in some cases were covered with a sheet of glass, and in others with a piece of wood.

"After the experiments were completed the soil and diseased bulbs were carefully examined, and apart from fungi no other pests were

[1] Journ. Economic Biol., 1909, Vol. IV, p. 83–86.
[2] Proc. Assoc. Econ. Biol., 1905, Vol. I, p. 14.
[3] Farm Insects, p. 432.
[4] Rpt. Obs. Inj. Insects for 1904, p. 110.
[5] Economic Entomology, Aptera, p. 404.
[6] The Collembola of Minnesota, 1903, p. 4.
[7] Rpt. on Inj. Insects for 1905, p. 10.

found, but in all cases the Collembola had inceased largely in numbers."

At the time it did not occur to me to inquire "where did the fungi come from?" But since then this same soil has in part been used to pot bulbs in and the remainder was thrown onto the garden. In the pots and in the garden where this soil was placed there is now arising an abundant crop of different fungi.

As none of the fungi have previously been noticed in the garden and do not now occur, excepting in this restricted patch and in the pots, I think I am justified in concluding that the spores were originally introduced by the Collembola.

Doctor Buller[8] in his recent work states: "The gills of expanded fruit bodies are frequently visited, not only by Fungus Gnats, but also by Springtails (Collembola) . . . Some fruit bodies of *Polyporus squamosus,* which were growing on a log and had not yet become fully expanded, were infested with small black Collembola. There were as many as fifty to the square inch, and each one occupied a hymenial tube which was just wide enough to hold it. The Springtails (genus *Achorutes*), infesting *Stropharia semiglobata,* and some other species of Agaricineæ, were found to contain spores in the midgut," and it is well known to students of this interesting order that large numbers are found in such habitats. Hence these minute insects, quite apart from their own depredations, may prove a source by which various plant diseases may be introduced by spores which they carry upon their bodies. This I have proved to be actually so by washing various species in water and then examining the liquid, after the removal of the insects, in such case spores of fungi were particularly numerous.

SOME NOTES UPON THE LIFE HISTORY AND HABITS OF THE SORGHUM MIDGE

(*Contarinia* [*Diplosis*] *sorghicola* Coq.)

By W. Harper Dean, *Agent and Expert, Cereal and Forage Insect Investigations, U. S. Bureau Entomology*

Contarinia sorghicola Coq. occurs practically throughout the sorghum producing sections of the United States east of the 100th meridian. West of this line it is not known to occur at this writing. This species infests the seed of the many varieties of Sweet Sorghum,

[8] Researches on Fungi, London, 1909, p. 20.

Kaffir Corn, Broom Corn, Milo Maize and Johnson Grass (*Sorghum halapense*).

In one instance the writer induced this midge to oviposit within the seed of the common Fox tail grass (*Setaria glauca*), although the latter had not been listed among the hosts of *C. sorghicola* Coq.

The females oviposit within the seed glumes, placing the eggs close to the ovary. The newly hatched larvæ absorb the plant juices from the ovary and remain close against the latter until they have completed their growth and transformed into pupæ. The pupæ work their way upwards from the ovary until the apex of the seed is reached. There they remain until the adult is ready to emerge. At that time the pupæ work their way still farther up until about two-thirds of their length projects from the apex of the seed. In this position the adult liberates itself, leaving the cast pupal skin attached to the spikelet.

The larvæ are not cannabalistic; often as many as six in different stages of growth are found within a single seed while the writer has frequently removed eggs, larvæ and pupæ from one seed.

The Sorghum Midge is most thorough in its destruction of a crop of seed. In Midge infested sections rarely less than 90% of the growing seed are infested during the height of the season. The first and last heads are the ones least infested.

Copulation takes place immediately after emergence of the adult, the males hovering about the sorghum heads and seizing the females as fast as the latter leave the pupal skin — often before their wings have dried sufficiently for flight.

Immediately after copulation and when the wings are sufficiently dry for flight the females begin ovipositing. This is continued energetically until the quota of eggs has been deposited.

The time required for development from egg to imago varies considerably and is largely controlled by prevailing temperature and humidity. In the low country of southern Louisiana the time was much longer than in south central Texas where the heat is extreme and humidity very low.

The parasite, *Aprostocetus diplosidis* Crawford, is the predominant Midge parasite in Louisiana. During the summer of 1908 this parasite was successfully introduced into the fields around San Antonio, Texas, by Prof. F. M. Webster through the coöperation of Prof. Wilmon Newell of the Louisiana Crop Pest Commission.

Tetrastichus sp. Craw. has been bred from Midge infested sorghum seed by the writer along with the parasite *Aprostocetus diplosidis* Craw.

The Argentine Ant (*Iridomyrmex humilis* Mayr) ranks first among the Louisiana predaceous enemies of the Midge. This ant has not been found by the writer in Texas. The Argentine Ant in Louisiana attacks the Midge when the latter is in the pupa projecting from the apex of the seed just prior to the emergence of the adult. In this position it falls a ready prey to this enemy which seizes the pupa between its mandibles and draws it from the seed.

In Louisiana and also in Texas the writer has observed the fly, *Psilopodinus flaviceps* Aldrich, capture the adult midge when the latter is crawling over a seed head preparatory to ovipositing.

Several species of *Odonata* have been observed by the writer evidently capturing adults of the midge as the latter swarm about the seed heads although actual dissection of the stomachs of these flies has not been made in order to settle this point definitely.

SOME INSECTICIDE TESTS FOR THE DESTRUCTION OF APHIDIDAE AND THEIR EGGS

By C. P. Gillette, *Ft. Collins, Col.*

For some years past I have been making comparative tests of different insecticides for the destruction of plant lice (*Aphididæ*) and their eggs. The object of this paper is to announce a summary of the more important results only. I shall not even take time or space to refer to the work that others have done along the same lines.

The more important substances used have been emulsions, soaps, lime-sulfur preparations; and tobacco extracts in which nicotine is supposed to be the only active agent.

For the Destruction of Eggs

Kerosene emulsion was used in 35 different tests. In 8 of these no eggs were found hatched. Of the 27 applications which did not fully prevent hatching, 19 were above 16% oil, 8 were above 33% oil, and 2 were 50% oil. With less than 25% oil in the emulsion the eggs seemed to hatch as well as those untreated. Eggs of 4 species, *Aphis pomi, A. viburnicola, Chaitophorus negundinis* and *Melanoxantherium smithiæ,* were used.

Scalecide was used in proportions varying between 5 per cent and 25 per cent. Eggs hatched from 20 out of 22 treatments and from all strengths.

Thompson's Soluble Oil was used in 14 tests and in strengths

varying between 5 per cent and 20 per cent. Some of the eggs hatched from all strengths used.

The conclusion reached was that none of these oils can be depended upon to kill eggs of plant lice, though the lice that hatch upon twigs treated with the higher strengths very largely die from contact with the oily surfaces after hatching.

With these miscible oils, eggs of the same species were employed as in the kerosene emulsion experiments.

Soaps—Bowker's Tree Soap and Good's Whale-Oil Soap were used for 77 different treatments in strengths varying from 2 pounds to 1 gallon of water down to 1 pound in 6 gallons. None of the eggs of *A. pomi*, *A. cornifoliæ*, *Ch. negundinis* or *Mel. smithiæ*, which were treated with 2 pounds to 1 gallon, hatched. Eggs of the same species, and also of *A. viburnicola* hatched poorly when treated with a preparation of 1 pound to 1 gallon. Weaker dilutions seemed entirely valueless.

Lime Sulfur Mixture made by the 15–15–45 formula was also used against eggs of all the lice above mentioned and also those of *Myzus elæagni*. In this strength the lime-sulfur was a marked deterrent to hatching but all species hatched to some extent and some rather freely. Weaker applications had little effect. Over 70 applications were made. Where strong lime-sulfur applications are made, many lice die from contact with the lime-sulfur while struggling to extricate themselves from the egg shell and others die after leaving the shell and before taking food.

I might add that eggs of *Bryobia pratensis* hatched freely after thorough treatment with the 15–15–45 strength of this mixture.

Rex Lime-sulfur was also used many times in one-fourth, one-sixth, one-ninth, and one-twelfth full strength and with no better results than were obtained with the home-made product just mentioned.

Tobacco Extracts

Black Leaf Extract was used twice in one-twentieth strength and no eggs hatched. It was used 8 times in one-thirtieth strength and no eggs hatched. Seven applications were made in one-fortieth strength and in 5 cases none hatched, but in the 2 others a very few hatched. Weaker dilutions did little good.

Nikoteen was used 23 times in strengths varying between 1 in 100 and 1 in 500 parts and in only 3 cases did any lice hatch and these were all *Myzus elæagni*. The eggs of this species were the most resistant of any used in the various tests.

Sulphate of Nicotine was used 54 times in strengths varying between 1 in 50 and 1 in 500 and in no instance did an egg hatch. The species used were *A. pomi*, *A. cornifoliæ*, *A. viburnicola*, *Ch. negundinis*, *Mel. smithiæ*, and *My. elæagni*. The last named species was not treated with dilutions below 1 to 150. Eight applications of 1 to 750 resulted in a few hatching in one instance only. In weaker dilutions the number hatching gradually increased.

Nico-Fume was used in 55 applications in which the dilutions varied between 1 in 50 and 1 in 1,000 and in no case did a single egg hatch. In 1 to 1,200 some hatched; in 1 to 1,500 more hatched, and in 1 to 1,800 still more.

I hardly dare give out these results with the tobacco preparations; they are too good. I shall not fully believe them myself until I have tested them out another year with similar results.

All the applications that I am reporting were made in an insectary and the eggs were treated by dipping the twigs bearing them 3 or 4 times in quick succession into the various insecticides and then setting the twigs in moist earth in the insectary to be under observation until the lice hatched or until all hope of hatching was past.

Results With the Lice

Time will not permit me to go into this part of the work except to state that, in a general way, the results with the nicotine preparations run parallel with those above given. Black Leaf killed most lice well, down to a 1 per cent dilution and Sulphate of Nicotine and Nico-Fume killed most lice, well down to 1 part in 1,000, Nico-Fume having somewhat the advantage over the Sulphate in results.

In closing I would like to call attention to the fact that there is a great difference in different species of the Aphididæ as to their power to resist the action of contact insecticides. The eggs of *Chaitophorus negundinis* were more easily killed than those of any other species that I have worked with while the eggs of *Myzus elæagni* were the most difficult to destroy. I have found a thorough application of either Sulphate of Nicotine or Nico-Fume in the proportion of 1–1,000 to either *Aphis pomi* or *Schizoneura lanigera* will kill 100 per cent of those actually treated, while a similar treatment of the black chrysanthemum louse, *Macrosiphum sanborni*, will not kill one. Even 1 part in 100 is hardly strong enough to kill the latter species well, and 1 part in 200 is very inefficient, if used in the usual manner.

I find, however, by adding a small amount of soap, 1 pound to 50 gallons, the efficiency of these tobacco extracts is greatly increased.

In case of *M. sanborni*, for example, I found the addition of soap enabled either Sulphate of Nicotine or Nico-Fume to kill well down to 1 part in 800 or even 1,000 of water. The action of the soap seems to be merely to cause the fluids to wet and spread out upon the surface of the bodies of the lice instead of accumulating in drops and running off.

INSECT NOTES FROM NEW HAMPSHIRE FOR 1909

By E. Dwight Sanderson, *Durham, N. H.*

Insect life was unusually abundant and injurious in New Hampshire in 1909.

Aphids were unusually common during the late spring and early summer. *Aphis pomi* did much more injury than usual, especially to young apple trees and there were numerous complaints of its work. *Aphis setariæ* was common on cherry and plum thruout the state, curling the foliage very badly.

The pear leaf blister mite (*Eriophyes pyri*) has been common on pear for many years but has never been reported as a pest of apple until the past season in which we have received several reports from different parts of the state. It is interesting that New York State seems to set the style in insect pests as well as in other matters and that the neighboring states soon have the same troubles. The only explanation of the appearance of this mite in its new rôle as an apple pest is that suggested by Professor Parrott to me which may be due to dry seasons, of which we have had three in New Hampshire.

The apple leaf hopper (*Empoasca mali* LeB.) has been remarkably abundant and has caused a speckling of the apple foliage by a seeming destruction of the chlorophyl sap. I have not been able to observe any particular injury to old trees altho the numbers of insects have caused our fruit growers some alarm.

The spittle insect on pine (*Aphrophora parallela*) was very abundant, as in 1908, but we have been unable to relate its work in any way to the so-called pine blight. Its work is of no economic significance so far as we have been able to observe. The Fall web-worm and other caterpillars affecting apples in late summer have continued to be abundant as during the last two seasons.

The antlered maple worm (*Heterocampa guttivitta*) devastated the same territory as in 1908 and its injury was fully as severe. We had hardly expected to see severe injury by it this year but in view of the repetition of the outbreak this year we can see no reason why it may not be expected to be destructive in 1910. The trees in the worst

infested area have now been stripped of their foliage two years. Last year most of them leaved out in the fall but this year I am informed that many of them have failed to leaf out again. Undoubtedly many have already been killed and should they be stripped again immense areas of hard wood will undoubtedly be killed. Should this occur it would be the most serious injury to forest trees by a leaf eating caterpillar of which we know in this country. So far no parasites have been observed which are doing very effective work against the pest but the ground beetles, particularly *Calosoma frigida*, were present in large numbers and undoubtedly did very effective work both as larvæ and adults. The striped maple worm (*Anisota rubicunda*) and the spiny oak caterpillar (*Anisota stigma*) were again abundant on maple and oak over the same territory affected by the antlered maple worm.

For the last two years the elm leaf beetle (*Galerucella luteola*) has been becoming more abundant in the cities in the southeastern part of the state. The present year many of the trees in Newmarket, Exeter, Dover, Manchester and Nashua were entirely stripped of their foliage where they had not been sprayed. Another season effective work will undoubtedly be done against the pest by spraying. The unusual prevalence of this insect so far north can only be accounted for by our exceptionally dry summers and the rather open winters of the last two years. It is beyond its northern range as previously known to us and we shall expect to see it disappear and only break out under similar climatic conditions in the future. It may be possible, however, as Dr. H. T. Fernald has suggested, that it, as well as some other insects, will adapt themselves to a more northern habitat.

The brown-tail moth (*Euproctis chrysorrhœa*) is increasingly abundant in the more recently infested territory but altho we have made no careful survey of its spread, it seems to be spreading but very slowly toward the Connecticut Valley and to have reached its northern limit as we have previously predicted. Practically no serious injury is done by the insect in most of the territory north of Lake Winnipesaukee. In the worst infested region, as for instance in Durham, over 95 per cent of the caterpillars were killed off by a fungous disease altho there was hardly a normal rainfall. With normal rainfall in the spring and late summer the pest will undoubtedly be greatly reduced in numbers in the future. Spraying with arsenate of lead to destroy the young caterpillars during the first two weeks in August has been found exceedingly effective and cheap for both apple and shade trees, both in our own work and in that of our fruit growers.

The gipsy moth (*Porthetria dispar*) continues to spread and we

regret to state that except for the work being done by the U. S. Department of Agriculture that practically nothing is being done for its control either by the enforcement of the law or by the education of the people. The outlook for any possible control of the gipsy moth in southern New Hampshire is exceedingly dark and we are inclined to the belief that the only result possible is a very general and widespread destruction of the timber in southern New Hampshire, particularly the white pine, upon seeing which the people will probably awake to the necessity of handling such problems in a thoro going and scientific manner. The boll weevil has been a great blessing to Texas. We have already seen a considerable benefit from the brown-tail moth in New Hampshire in compelling the care of neglected orchards and the destruction of scattering trees. It is quite probable that the gipsy moth may be the means of arousing an appreciation of the value of our timber and shade trees and the rational growth and care of farm woodlots.

INSECTS NOTABLY INJURIOUS IN LOUISIANA DURING 1908 AND 1909

By Arthur H. Rosenfeld, *Baton Rouge, La.*

This article is prepared as a sort of continuation of the article by Mr. Wilmon Newell and the author, published in Volume 1 of the Journal of Economic Entomology.[1] We realize that a paper of this nature is not of particular interest at a meeting of this kind, nor does it require a great amount of scientific acumen to prepare such an article; however, we think that the value of such papers for reference use justifies their presentation here.

Cotton Insects

Practically the entire cotton area of Louisana, embracing some 34,000 square miles, is now infested with the boll-weevil, *Anthonomus grandis* Boh. As a result, the cotton acreage of the state has been much reduced, and this season Louisiana has made the shortest crop in all of her history — about 273,000 bales, against 517,000 in 1908, 610,724 in 1907, and 769,222 in 1906.

The boll-worm, *Heliothis obsoleta* Fab., has been, as usual, present in all parts of the state, but has not been particularly severe during the past two years.

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[1] "A Brief Summary of the More Important Injurious Insects of Louisiana," Jour. E. E., Vol. I, page 150.

Neither the cotton caterpillar, *Alabama argillacea* Hübn., nor the square-borer, *Uranotes melinus* Hübn., have made their presence particularly felt during the past two years, but the past spring the cotton aphis, *Aphis gossypii* Glov., was very abundant, and badly injured the stand of cotton in many cases. This was undoubtedly due to the cold April. The cotton aphis is always a serious pest in cold, wet springs.

The cowpea pod-weevil, *Chalcodermus æneus* Boh., seems to be decidedly on the increase, judging from the large number of reports and specimens we have received during the past two springs. Early in the season, while the pod-weevils are waiting for cowpeas, they heavily infest the cotton, and often materially injure the stands by puncturing the leaf and terminal stems of the plants.

The garden web-worm, *Loxostege similalis* Guen., the differential locust, *Melanoplus differentialis* Thos., and the leaf-footed plant bug, *Leptoglossus phyllopus* Linn., have caused little trouble.

Sugar Cane Insects

The two principal cane insects, the cane borer, *Diatræa saccharalis* Fab., and the "pou-á-poussiere," *Pseudococcus calceolariæ* Mask., have been about normally abundant, although we have found that the infested territory is larger than we knew of in 1907, in the case of both insects. The Bureau of Entomology has taken up a study of sugar cane and rice insects, in coöperation with the Louisiana State Crop Pest Commission, also a study of the Argentine ant, which is supposed to be the principal means of transportation of the "pou-á-poussiere."

Insects Injurious to Cereal and Forage Crops

None of our principal corn insects, the boll-worm, the cane borer, or the Southern corn root-worm, *Diabrotica duodecimpunctata* Oliv., have been more than usually abundant on corn.

The rice maggot, *Lissorhoptrus simplex,* Say, did a great deal of damage the past spring. Thousands of specimens were sent into the Commission, which had flown to lights.

The sugar-cane beetle, *Ligyrus rugiceps* Lec., was not reported as unduly numerous, but the author noticed vast numbers of them at Crowley, La., in the heart of the rice-belt, attracted to the lights of the city. Thousands of them were lying upon the walks under each electric light, and they were flying into houses and stores in great abundance.

The fall army worm, *Laphygma frugiperda* Sm. & Abb., was seriously abundant in some sections, particular injury being done to young rice. The author saw one 10-acre corn field near Hammond, La., made as bare in a few days as if there had been no crop on the land whatsoever.

The destructive pea aphis, *Nectarophora pisi* Kalt., and the onion thrips, *Thrips tabaci* Lind., did considerable damage in St. Bernard Parish, the extreme southeastern parish of the state, though the damage was not as serious by either species as in 1907.

Truck Crop Insects

A few specimens of the Colorado potato-beetle, *Leptinotarsa decemlineata* Say, have been received at the office of the Commission, but this insect is usually conspicuous by its absence.

The sweet potato borer, *Cylas formicarius* Fab., has been, as usual, quite common in South Louisiana, and the ever-present Harlequin cabbage-bug, *Murgantia histrionica* Hahn., has been heard from only occasionally.

The imported cabbage worm, *Pontia rapæ* Sch., has been more numerous the past fall than in many years. On account of decreased cotton acreage, considerable truck has been planted in some sections of Louisiana, and a large amount of fall cabbage was this year grown. Most of the cabbage growers are yet unfamiliar with the insects attacking this crop, and, as a result, the imported cabbage worm did an unusually large amount of damage.

The past fall, also, was notable for its tremendous number of bean leaf-beetle, *Ceratoma trifurcata* Forst. Cowpeas and all sorts of beans were badly riddled, and applications of arsenate of lead seemed to have little effect.

The striped cucumber beetle, *Diabrotica vittata* Fab., was another common insect which was unusually numerous the past season.

The squash lady beetle, *Epilachna borealis*, Fab., is always found in small numbers, scattered over the state.

Insects Injurious to Stored Products

The insects in stored food-stuffs, etc., in Louisiana, are legion. Among the commonest are the drug-store beetle, *Sitodrepa panicea* Linn., the saw-toothed grain-beetle, *Silvanus surinamensis* Linn., the rust-red flour beetle, *Tribolium ferrugineum* Fab., the cadelle, *Tenebrioides mauritanica* Linn., the cigarette beetle, *Lasioderma testaceum* Dufts, the rice weevil, *Calandra oryzæ* L., the granary weevil,

Calandra granaria Linn., *Alphitobius diaperinus* Panz., *Rhizopertha pusilla* Fab. and others.

Our three most common cockroaches are the American cockroach, *Periplaneta americana* Linn., a closely related species, *P. brunnea* Burm., and the cosmopolitan croton bug, *Blatella germanica* Linn.

Insects Affecting Deciduous Fruits

The same Coccids as were noted in the article by Newell and Rosenfeld, mentioned above, have been noticed during the past two years, and none have increased to an alarming extent. The San José scale, *Aspidiotus perniciosus* Comst., has been held well in check in the nurseries in which it occurs, and we have not been able to locate any newly infested districts for the West Indian peach scale, *Aulacaspis pentagona* Targ.

In September last, Mr. C. W. Flynn, while inspecting nurseries in New Orleans, sent in some Coccids on young fig trees from China, said by the nurseryman to have been brought to him by a sea-captain. Doctor Howard identified these scale insects as *Asterolecanuim pustulans* Ckll. Mrs. Fernald, in her catalogue, gives as the habitat of this insect, Jamaica, Portò Rico, Antigua, Brazil, Br. Guiana, Grenada, Monserrat, Mexico and Florida. As this is a new insect to us in Louisiana, we had the nurseryman destroy the few fig trees infested.

The peach-borer, *Sanninoidea exitiosa* Say, and the plum-curculio, *Conotrachelus nenuphar* Herbst, have been about normally abundant, but the shot-hole borer, *Scolytus rugulosus* Ratz., has done more than its usual damage, especially to peach, this being doubtless due to the fact that a late freeze last spring materially weakened a number of peach trees which were pretty well advanced.

The woolly apple aphis, *Schizoneura lanigera* Hausm., and the apple-tree tent caterpillar, *Malacosoma americana* Fab., have been very little in evidence of late. This is also true of the American procris, *Harrisina americana* Guer.

An insect which we did not before know to occur in the state is the strawberry root louse, *Aphis forbesi* Weed. In April, 1908, a few specimens were sent in, and an investigation by the writer revealed the fact that it was very common all over Tangipahoa Parish, our principal strawberry section. During the past spring this insect was also found by the writer at Baton Rouge.

The destructive mealy-bug, *Pseudococcus citri*, Risso, is commonly abundant on figs, Japanese persimmons, and oranges.

Citrus Fruit Insects

On the orange insects there need be no especial comment except in the case of the white fly, *Aleyrodes citri* R. & H. This insect has again gained a foothold in Plaquemines Parish, the principal orange-growing section of the State, and this season has done considerable damage. Efforts are being made to hold this insect in check by means of the various fungus enemies which have given good results in Florida, and with fair results. The white fly was formerly very abundant in the orange groves of Plaquemines Parish, but was practically eradicated there by the destructive freeze of February, 1899, which killed most of the orange trees in Louisiana and Florida.

Insects Injurious to Pecans

The walnut caterpillar, *Datana integerrima* G. & R., has done considerable damage to pecan foliage, while the fall webworm, *Hyphantria cunea* Dru., and the hickory twig-girdler, *Oncideres cingulata* Say, have been about normally abundant. More than the usual number of complaints of attacks of the pecan huskworm, *Enarmonia prunivora* Fitch, have been received.

In December, 1908, Mr. T. C. Barber collected a number of newly budded pecan branches (ring budded) which showed indications of the attack of boring larvæ. On investigation a number of Sesiid larvæ were found, in one case thirty being dug from a single limb. They seemed to enter through the wound caused by the budding and to work upwards from the bud. This caused a large swelling at the point of injury, which was covered with the borings of the larvæ. Three infested limbs were placed in the insectary, and in March the adults began to emerge, something like fifty specimens emerging from these three small pieces of infested limbs between March 24 and April 28, 1909. Doctor Dyar kindly identified the moth as *Sesia coruscа* Hy Edw.

The obscure scale, *Chrysomphalus obscurus* Comst., has been found abundant on pecan trees all over Louisiana. *Cecidomyia caryæ* O. S. is also abundant in all parts of the state, on wild pignut as well as on cultivated pecan.

We have on record one case of severe injury to a pecan tree at Morgan City, La., by an ambrosia beetle, identified by Prof. F. H. Chittenden, of the Bureau of Entomology, as *Platypus compositus* Say.

The two May beetles, *Lachnosterna prunina* Lec., and *L. fusca* Froh., which were very destructive locally in some sections in north-

west Louisiana in 1905, have not made their appearance in such destructive numbers since that time.

Insects Injurious to Shade and Ornamental Trees

In this class we have found nothing of especial importance, the pests mentioned in the above-mentioned article being present in about normal quantity. The Gulf Fritillary, *Dione vanillæ* Linn., is almost always found upon the passion-vine, *Passaflora incarnata,* with which a number of the galleries in various parts of South Louisiana are covered, and the dropping of the spiny red and black "worms" has "almost caused" untold cases of feminine hysterics!

The larvæ of *Homaledra sabalella* Cham., (kindly identified by Mr. Busck), have caused considerable injury to palms in Calcasieu Parish, in the southwestern part of the state, during the past summer. They fold the leaves and feed inside the inclosure thus made, skeletonizing the leaves.

Insects Attacking Men and Live Stock

Nothing of interest has transpired among these insects during the past two seasons. We have had no severe outbreaks of the buffalo gnat, *Simulium pecuarum* Riley, reported to us. This insect at times appears in destructive numbers, and the loss of a large amount of stock always results. The horn-fly, *Hæmatobia serrata* R.-D., has been very abundant in parts of the state, and has caused considerable annoyance to farmers in the infested districts. The various species of *Tabanus* and *Chrysops* have been noticed in about their usual numbers.

The chicken mite, *Dermanysus gallinicæ* Redi, has been several times sent into the office with complaints of injury and annoyance.

NOTES ON CALOSOMA FRIGIDUM KIRBY, A NATIVE BENEFICIAL INSECT[1]

By A. F. Burgess, *Melrose Highlands, Mass.*

During the past three seasons extensive investigations have been carried on at the Gypsy Moth Parasite Laboratory at Melrose Highlands, Mass., in order to secure more accurate knowledge of the biology of the European parasitic and predaceous insects that are being introduced for the purpose of securing the natural control of the Gypsy and Brown-Tail Moths. Considerable data has also been obtained concerning native species which destroy some of our common

[1] Occasional contributions from the Gypsy Moth Parasite Laboratory, III.

insect pests, an unusual opportunity was offered in 1909, on account of the extreme abundance of the Saddled Prominent (*Heterocampa guttivitta*) in Maine and New Hampshire.

For two years previously large areas of deciduous forests in these states had been defoliated by this insect, and its unusual abundance and the noticeable character of the injury caused led many land-owners to fear that irreparable damage would result. During the summer of 1908 reports relative to this insect were issued by Miss Edith M. Patch,[2] Entomologist to the Maine Agricultural Experiment Station. Prof. E. F. Hitchings, State Entomologist of Maine, and C. F. Jackson[3], Assistant Entomologist, New Hampshire Agricultural Experiment Station, and last summer the outbreaks of the previous year were followed up by the above officials and their assistants.

In each of these reports mention was made of the fact that certain predaceous beetles, particularly *Calosoma frigidum,* were found in considerable numbers in the badly infested sections and as this genus of beneficial insects is receiving special study in connection with the Gypsy moth work, it seemed desirable to secure as much data as possible to determine whether the species was doing any considerable amount of good.

Accordingly an arrangement was made with Prof. E. D. Sanderson and on July 31 Mr. W. F. Fiske and the writer accompanied Professor Sanderson on a tour of a part of the infested district in New Hampshire. A visit was made to several badly infested localities in the town of Tamworth, in the foothills of the White Mountains and a colony of larvæ of the European beetle, *Calosoma sycophanta* was liberated. These insects had been reared at the Parasite Laboratory in Massachusetts and previous to this time over 6,000 had been liberated in Gypsy moth infested colonies in that state. The caterpillar stage of that insect having passed, it was thought desirable to liberate this colony in New Hampshire where the beetle larvæ could obtain sufficient food to attain full development. Adults of *Calosoma frigidum* were common in this locality, where they were observed climbing the trees and feeding freely on the *Heterocampa* larvæ. No beetle larvæ were observed at this place. Another badly infested area was visited in the same town. A large acreage on the hillsides had been completely defoliated and many *Heterocampa* larvæ were crawling about on the ground and the trunks of the trees in a vain search for food. This area had been defoliated the previous year. Many beetles were

[2] Bulletin No. 161, Maine Agricultural Experiment Station.

[3] 19th and 20th An. Repts. N. H. Agric. Expt. Sta., 1908, p. 514–531.

found and several larvæ were seen on the ground feeding on the caterpillars. A square yard of ground was carefully examined by Mr. Fiske and the writer, and 12 *frigidum* larvæ were found just beneath leaves and litter. They were busily engaged in feeding on the caterpillars that had crawled under the forest cover for the purpose of pupation.

On the following day a badly infested area was examined near White Horse Mountain, near North Conway, and although it was not possible, owing to lack of time, to make a thorough survey of the defoliated area, very little search was required to discover many of the beetles. This colony was located on the side of the mountain and the caterpillars were not as far advanced as those seen at Tamworth. At one place on the edge of the badly infested area upwards of 100 beetles were found busily engaged in climbing the trees and feeding on the caterpillars. Few *Heterocampa* larvæ were found under the leaves and no beetle larvæ were seen.

Mr. C. O. Bailey, Secretary to the Massachusetts State Forester, informed me that while driving at Effingham, New Hampshire, August 1, 1909, he observed large areas of woodland that had been stripped by *Heterocampa*. At one place the trees had been completely defoliated and countless numbers of the caterpillars were seen crawling across the road. They were being attacked by *Calosoma frigidum*, which species was present in large numbers.

As few parasitic insects were observed it was thought desirable to make another trip later in the season in order to check up the data secured, and accordingly on August 21 Mr. Fiske and Mr. Harry S. Smith went to North Conway for that purpose. After finishing the investigations made in the localities visited on the previous trip Mr. Fiske returned, and Mr. Smith spent several days examining other defoliated areas on Mount Kearsarge and in the surrounding territory.

A summary of the notes made by Mr. Smith, so far as they relate to *Calosoma frigidum*, has been very kindly placed at my disposal, while those bearing on certain parasitic forms will be used by him after more information has been secured next season.

At the time of this visit *Heterocampa* were nearly all in the pupal stage beneath the leaves and rubbish on the ground, and as *frigidum* larvæ were present in considerable quantities, and actively engaged in feeding on the pupæ counts were made to determine the relative percentage of pupæ destroyed. About a square yard of ground was examined in each locality, 29 sets of data being secured. In five of these no *frigidum* larvæ were found but the number of pupæ that

had been destroyed ranged from 60 to 100 per cent, the average being 78 per cent by the beetle larvæ and 4.5 per cent by all other enemies. In these areas the trees had been stripped early in the season and the beetle larvæ had become full grown and gone into the ground to pupate before the examination was made.

In the remaining 24 areas examined *frigidum* larvæ ranging from newly hatched to nearly full fed were found. In one case 21 larvæ were discovered feeding on pupæ. At this time the number of pupæ that had been killed by the larvæ of *frigidum* varied from 11.7 per cent to 80.2 per cent, the average being 54 per cent of the total number of pupæ. Where the lower percentages were found a considerable number of small *frigidum* larvæ were present. The following table has been compiled from the data secured:

TABLE SHOWING THE NUMBER OF *HETEROCAMPA* PUPÆ DESTROYED BY LARVÆ OF *CALOSOMA FRIGIDUM*

Stages of *C. frigidum* larvæ found				Pupæ of *Heterocampa*				
First	Second	Third	Adults	Healthy	Eaten	Parasitized	Diseased	% Destroyed
2	2	2	2	17[1]	4	....	4	15.3
3	8	7	1	15	30	....	1	62.5
....	4	....	....	23	15	....	....	39.4
2	4	15	....	8	37	....	....	80.2
1	2	....	....	50[2]	9	....	2	14.7
1	1	3	1	6	8	....	....	57.1
....	2	....	1	14	2	....	1	11.7
....	....	1	....	3	4	....	....	57.1
....	....	1	....	6	21	3 ?	....	70.0
1	3	2	....	19	16	....	1 heat?	44.4
....	2	3	....	10	11	....	2 "	47.8
1	1	8	....	14	37	....	....	72.5
....	1	2	....	27	51	....	....	65.8
....	4	3	....	47	44	....	....	48.3
....	1	....	....	13	10	....	....	43.5
2	3	6	....	36	39	....	....	52.0
....	1	1	....	14	16	....	....	53.3
....	1	1	....	1	19	....	....	95.0
1	2	1	....	6	10	....	....	62.2
1	....	7	....	34	38	....	....	52.5
....	....	1	....	12	28	....	....	70.0
....	2	1	....	30	52	....	....	63.4
....	....	1	....	23	15	....	....	39.5
....	....	1	....	39	50	....	....	56.1
15	44	62	5	467	566	....	....	....

Several of the larvæ included under the column "Diseased" probably died from exposure to heat.

No later examination of this territory could be made so it is impossible to state from actual counts the percentage of pupæ that were destroyed before the beetle larvæ became full fed.

The data available showing the amount of food consumed by the larvæ of *frigidum* in its different stages is far from complete but from such feeding records as have been obtained at the Gypsy Moth Parasite Laboratory, together with those secured by the writer several years ago when the life history of this species was investigated,[4] it appears that the following amount of food for each stage is a very conservative estimate; first stage 2, second stage 5, and third stage 7 full grown gypsy moth larvæ.

If the beetle larvæ found continued to feed until full grown or until the food supply was exhausted, as would be the case in some of the areas examined, they would at the end of the season destroy, on the average for all the areas examined, 92 per cent of the pupæ present.

It is, of course, impossible to determine the number of *Heterocampa* larvæ that were destroyed by the beetles and their larvæ but from the above data it is easy to see that the increase of the species was greatly retarded during the past season, in the localities mentioned, by this beneficial insect.

Calosoma frigidum is found throughout New England and is often present in large numbers during outbreaks of caterpillars. There are specimens in the United States National Museum at Washington, D. C., which were taken in Illinois, Maryland and Michigan, which indicates that this insect has a wide range.

It is probable that the unusual increase of this species in the infested district in New Hampshire is due largely to the abundance of a satisfactory food supply. A study of the reproductive habits of a limited number of specimens, made by the writer in 1896, showed that 186 eggs were deposited, in one case, by a female fed in captivity, and observations which were continued the following year led to the discovery that eggs are laid by some females for two successive years. The habit of the *Heterocampa* larvæ of pupating on the ground beneath leaves and rubbish makes them particularly susceptible to the attack of the larvæ of this beetle, which naturally feed in such situations. The larvæ of *Calosoma sycophanta* have been found climbing trees, especially those that have rough bark, where they

[4] Notes on certain Coleoptera known to attack the gypsy moth, 44th Annual Report Mass. State Board of Agriculture, 1896, p. 412–426.

feed on caterpillars and pupæ of various insects. *Frigidum* larvæ were not observed on tree trunks in the areas examined in New Hampshire but it was not necessary for them to climb as plenty of food was available on the ground.

Miss Edith M. Patch has found these larvæ, as well as the beetles, feeding on *Heterocampa* caterpillars, on tree trunks, which shows that it is possible for the larvæ to climb to secure food in case it is necessary to do so.

The abundance of *Heterocampa* next summer in the sections examined will, of course, offer interesting data on the value of *Calosoma frigidum* in controlling this insect.

This concludes the Proceedings.

A. F. Burgess, *Secretary.*

Panama Ticks.—We notice in Mr. Hooker's list of Dec., 1909, p. 415, of ticks from Panama no mention of two of our common species, *Amblyomma dissimile*, the common iguana tick of this region, and *Amblyomma varium*, taken from *Bufo marinus*, our common toad; determinations made by Banks and Hunter. This last tick has been of some interest to us for it is probably the intermediary host of *Filaria* sp., and also of a Hemogregarine. Sections of adult ticks showed undoubted development of filaria embryos. The blood of every one of eight specimens of this toad contained filaria embryos, and each one of the adults dissected had three or four adult filaria in the lymph sinuses. The blood of five of the toads contained the hemogragarine. All of the toads were infected by *Amblyomma varium*.

Dr. Samuel T. Darling,
Chief, Board of Health Laboratory, Ancon Hospital, Isthmus of Panama.

Proceedings of the Eighth Annual Meeting of Horticultural Inspectors[1]

(Continued from the February issue)

Evening Session, December 26, 1909, Continued.

President Washburn presiding.

The President presented Professor Surface, who read the following paper:

RESULTS OF VARIOUS REMEDIES FOR SAN JOSE SCALE, IN PENNSYLVANIA ORCHARDS, AS SEEN BY THE INSPECTORS IN THE ORCHARDS

By H. A. SURFACE, *Harrisburg, Pa.*

[Withdrawn for publication elsewhere]

WHAT SHOULD BE THE FORM OF OUR CERTIFICATES?

By FRANKLIN SHERMAN, JR., *Raleigh, N. C.*

For some years I have been considering whether we entomologists (especially those of us in the eastern states) can devise some method of bringing our certificates of nursery inspection more nearly in line with the facts as they really exist. I violate no confidence in saying that the certificates as now issued in all of our eastern states are

[1]A CORRECTION

It appears that Professor Headlee was incorrectly reported on pages 80–81 of our February issue. The following is therefore inserted at his request and gives the tenor of his remarks.—ED.

The Farmer's Institute organization in Kansas has been able to engage a practical, up-to-date horticulturist. This man goes about the state conducting the fruit-production side of the regular institutes. He meets with fruit growers, finds out their problems, and gives them the benefit of his long and successful experience. On request he visits individual fruit plantations, looks carefully into local conditions, and suggests methods whereby the yield may be improved.

In general, our people do not know how to grow high grade fruit, although our regular fruit growers produce fruit that will compare very favorably with the best grown in the country. The Farmer's Institute organiza-

misleading to one not on the inside. We all know how binding are the conditions which have led us into this practice and I cannot say that I am yet quite ready to take a step which shall make North Carolina appear different from all her neighboring states, for such a step could, and probably would, be seized upon by some nurseries in other states and used to our disadvantage, when those very nurseries would likely be no better, and perhaps worse, than our own home nurseries.

Now the essential point of our present system which I object to is this:— We give certificates which are so worded as to plainly imply that the nurseries are "free, or apparently free," from the San José Scale, and we issue these certificates after scale *has* been found in the nursery, we issue them to nurseries where it has been found with more or less regularity for years past, where we know the scale is well established, and where we are reasonably sure that it will be found in the future. We fully recognize the fact, and freely admit it among ourselves, that it is not practicable, nor would it be just to bar a well-established nursery from trade, when it has won a large number of loyal customers many of whom would rather take the stock of that nursery even without certificate and taking the chance of scale, rather than to deal with someone else. Then again, there is the complication that much of the stock is really sold through agents or advance orders, long before the nursery is inspected.

But perhaps the most irritating fact of all is that if one of us, in the zeal of clearing his conscience and of trying to make the deed square with the word, were to actually knock out every nursery in his state which was found to have San José Scale,—that state might at once become a most profitable field for exploitation by nurseries in other states who were in the possession of certificates that they were "apparently free" and which as a matter of fact might be, and very likely would be, in worse condition than the nurseries that were put

tion is trying, through education, to bring about the production of better fruit. At present the horticulturist does not have many requests for consultation, but the number is increasing and no doubt in a short time he will have far more than he can attend to.

Kansas is a large state and although the eastern and central portions will produce excellent fruit-bearing trees and shrubs, many parts of the west will grow orchards only under irrigation.

In Kansas the fruit institute movement has just made a beginning. The Farmer's Institute, of which the fruit institute is just one phase, is organized and looked after by a special agent known as the Superintendent of Farmer's Institutes. This official has his office at the agricultural college and his work has met with such keen appreciation that the last Legislature voted $50,000 to carry it forward.

out of business,— for the very entomologist who would be so strict and so conscientious as to take this step is the very one whose state nurseries would likely be in as good condition as any. Hence no one of us has felt that he could afford to take the step, and we have all preferred to compromise ourselves to this extent rather than expose our nurseries to unfair competition and to subject the fruit-growers and farmers of our states to exploitation in the way described.

It seems to me that we have now reached the point where a change should be adopted, or at least tried experimentally. The San José Scale is now so wide-spread through all the eastern states that it is idle to talk of keeping our fruit-growing sections clear of it,— it is already present in almost every locality where there are extensive orchards, and in many such localities it is to be found in practically every orchard. Also it is no longer a pest which must be fought by preventive measures chiefly, for the remedies are so well known that there is no excuse for trees being killed by it *after the owner once knows of its presence.*

Then again let us remember that under the head of "serious insects and diseases" which our certificates are intended to cover, are included such pests as woolly aphis, crown gall, oyster shell scale, brown-tail moth, etc. I cannot believe that all the nurseries which we certify can by any stretch of the imagination be considered as even "*apparently* free" of all these.

I have therefore prepared for the consideration of this meeting a proposed form of certificate which I should like to have discussed. Here it is:—

THIS IS TO CERTIFY:—

That a duly authorized and competent inspector has made inspection of the salable nursery stock of ———— at ———— N. C., to ascertain condition as to insect pests and plant diseases, and said nursery is licensed until the expiration of this certificate.

This certificate may be suspended or revoked for cause.

THIS CERTIFICATE EXPIRES SEPTEMBER 30, 1910.

Dated,—Raleigh, N. C., ———— 1910.

————,

Entomologist.

I do not see as such certificate would give an unscrupulous nurseryman any advantage which he does not already have, nor do I see that it would take from the entomologist any advantage that he now has. I do not believe that "the ultimate consumer" would care a snap about the changed wording just so his protection is not weakened. We could retain the same privilege which some of us now use, of

requiring other nurseries to get tags from us before shipping into our state,— we could still have the right to destroy infested shipments. Nor do I believe that it would be injurious to those nurseries which are really apparently free from San José Scale.

However, I do a little bit fear that if we were to make such a change in our certificate, there would be some very enterprising nurserymen from some of the states which *might not* adopt the change, who would flood the other states with agents who would tell the people that our state nurseries were admittedly unsafe to buy stock from and then in support would show that we did not give a statement of freedom from scale, while their state did!

Altogether, I must confess that I am not immovably set in my conviction that this scheme would work entirely well, but I would be willing to go home, broach it to the nurserymen and fruit-growers of my state and adopt it for the coming year, if enough others would join with me to give it a really full and fair trial.

Tuesday Evening, December 28, 1909

Discussion in regard to certificates, as proposed by Sherman:

Mr. Phillips: In all cases the stock should be examined, and it should be understood that no certificate should go on any stock carrying the San José scale.

My inspectors are instructed not to pass trees that are infested with San José scale. All plants so marked are condemned and destroyed.

President Washburn: This is really very interesting. We would like to hear from other members.

Mr. Phillips: We have discussed this matter year after year; in fact, we had an important meeting in Washington a few years ago, and discussed about the same idea, although we did not present it in the form of a certificate.

At that time it was decided that the time had not come for making a change. I think Mr. Sherman's ideas are very good, and touch a point on which I would like to get an expression from the Association.

There is always some nurseryman here and there who has lost a few dollars by not keeping his nursery stock clean, and has objections to raise to inspection, and in order to get an understanding as to how this Association feels in regard to this certificate, I would like to make a motion that if such a certificate as Professor Sherman indicates is issued, and has the endorsement of the Association, that it shall not

cover a single tree infested with San Jose Scale, any more than any certificate mentioned heretofore; in other words, that the certificate be understood not to cover a single tree infested with San José Scale.

Of course, every one knows that you will find a tree now and then slightly affected. The idea I want to get at is that infested or affected trees should not be sent out from the nursery, and I make a motion to emphasize this point.

President Washburn: I think perhaps Mr. Phillips' motion is a little premature. We can use it later on.

Mr. S. J. Hunter: In Kansas when inspection is made and scale is found on a man's premises, regardless of whether it is in his nursery stock or in his orchard no certificate of inspection is issued. The nursery stock receives a tree to tree inspection and all stock destroyed within dangerous proximity of any stock found infested. The stock which is left is subjected to the standard fumigation process under the immediate direction of an inspector. Each consignment of this stock is accompanied by a special tag stating that such has been fumigated and giving the exact invoice of the consignment.

Mr. Burgess: Although I was not present when the paper was read, I would suggest that the certificates should show that the nursery had been examined and that the stock contained in each shipment was apparently free from injurious insects and plant diseases. I can see no deception in issuing such a certificate even if a slight infestation was found in the nursery at the time of inspection, provided the inspector has taken every precaution to free the premises from infestation and that he is satisfied that the stock shipped is free from pests as stated in his certificate. If the stock is fumigated before shipment I believe a certificate to that effect is an advantage.

President Washburn: I think the statement which Mr. Burgess just made is right to the point. I believe this is a matter which can safely be left to the good sense of the inspectors. Our common sense will tell us when a nurseryman has good stock, and if he is entitled to his certificate. I do not believe any of us would give a man a certificate if he did not deserve it.

SOME OBSCURE DISEASES OF PEACH

By J. B. S. Norton, *College Park, Md.*

Introduction

Perhaps most of our cultivated plants are troubled with many physiological diseases of more or less consequence, many of which, though they may cut off the crop seriously each year, do not receive notice, as their symptoms are not marked enough to attract attention as specific diseases; though some are well known because so serious that they could not escape notice by either cultivators or pathologists.

It is comparatively easy to work with a disease when the cause can be easily seen with the naked eye, as with most of our insect troubles. And if by careful microscopic work a pathogenic fungus or bacterium can be discovered, it is again a more or less simple matter. So much so, that practically all of our training has been along the line of insect and fungous parasites; a basis for pathological work which is not strictly logical, as these are only parts of the more fundamental science of pathology which deals with all abnormal variations in nutrition, respiration, stimulation, etc. But, we instinctively look for a parasite and are baffled when we come to a serious disease without any causative organ other than the diseased plant itself.

So far as I know the peach has more serious diseases, the cause of which has not been definitely determined, than any other crop we grow. It is only by extensive study of these under a great variety of conditions that we can obtain accurate information on such disturbances in plant health, and for that reason, I wish to here give a brief account of such as have come to my notice from personal experience and a recent examination of the available literature.

Not all the diseases, the causes of which are unknown may be nonparasitic; some may be caused by yet unknown bacteria, fungi, insects or other animal parasites, and in that case or even if due to a contagious ferment, as may be the case in the yellows, may come under the domain of the horticultural inspector.

Yellows

I shall mention first what has been determined about peach yellows. (See Erwin Smith, also Clinton and other recent authors.) Briefly, this is a definite disease, characterized by premature ripening of the fruit, which is peculiarly red blotched, internally red streaked, and of poor quality, premature growth of leaf-buds, and even flower-

buds, producing small, narrow and usually yellowish foliage, and later clusters of weak shoots, followed in three to six years by death. It was first known near Philadelphia over one hundred years ago and is now found from Canada south to central Delaware and Maryland, from thence extending southward east of the mountains to Georgia. Westward it is serious in Ohio, Michigan, etc., and occurs west of the Mississippi as far south as Arkansas. It has not spread southward very much in Maryland and Delaware, in twenty years. In the region where it is found, it is constantly present, but has had several much more serious outbreaks; sometimes destroying ninety per cent of the orchards in one year.

Yellows can be transmitted to a healthy tree by union with a living portion of a diseased tree, but in no other known manner, except to some extent by means of diseased pits, of which, however, only a small percentage usually germinate. (Warren [N. J. 1906] got twenty-seven per cent germination from 620 natural pits and only two per cent from 321 of four varieties of canning house pits; see also Phillips' work in Virginia.) It has been noticed that in orchards where diseased trees are kept cut out, fewer new cases appear, indicating some other kind of infection.

The disease is present in the tree some months before it is apparent and may show first only in a part of the tree. It cannot be cut out in such cases, and though diseased wood is lacking in lime and has an excess of potash, it cannot be corrected by fertilizers. It also attacks apricots, almonds and Japan plums and similar diseases occur in several herbaceous plants and some other trees. It is not due to root aphis, lack of iron, or any kind of impoverished soil; if anything, the trees making more vigorous growth being more subject to yellows. Overbearing, also, is against the disease rather than favoring it.

Many fungicides, including Bordeaux mixture sprayings and many secret remedies have been tested without success. No case of recovery is well authenticated. Many theories as to cause have been tested and inoculations with many fungi and bacteria have been tried without success.

The distribution indicates a relation to a certain climatic zone and many observations point to an increase of yellows after injurious weather conditions, such as drouth, following severe winter or late spring freezes. Individual trees show great resistance and some varieties seem more resistant in some cases than others. None are immune, not even naturals. Trees have lived in infected districts for fifteen to thirty years and then died of the disease. (Morse cites

the case of the White Magdalen variety that has grown 150 years in Massachusetts without contracting the disease.)

Since in our work we have to do more work with this disease than the others I shall mention, I shall take a little more time with it and mention some of the points which are in much need of further study, as apparently no extensive scientific work has been done on this important disease for nearly twenty years.

First. Can the disease be communicated by the pruning knife, contact, etc., or by sap or other non-living matter from diseased trees?

Second. Can the disease be produced in healthy trees far south of the yellows region by budding from diseased northern stock? Also would young diseased trees recover if transported to the south? Apparently any quantity of trees have been sent south from infected districts without spread of the disease, though healthy trees from the south have not shown immunity.

Third. The southern and western limit of the disease should be again accurately determined, and a careful survey of the infected region made to determine if there are within it isolated areas free from the disease. The border line should be completely explored for cases of recovery or recent extension of the disease limitation.

Fourth. What is the relative resistance of different varieties? Old trees standing for years after the surrounding ones have gone out with yellows should be propagated from to secure possible resistant stock.

Fifth. Tabulate from orchard inspection and weather records accurately kept for many years, the relation of warm, cold, wet and dry seasons and late spring frosts to increase or decrease of yellows in following years. Three or four seasons records in Maryland indicate that yellows outbreaks follow severe cold after buds open in spring. In this connection, the influence of different slopes or exposure and effect of late and early blooming might be considered.

Sixth. Careful examination of records should be made to certainly determine whether removal decreases infection or spread, bearing in mind the possibility that new cases may be due to climatic or soil conditions.

Seventh. We need a thorough chemical study of the relative amount of organic compounds associated with nutrition such as, starch, sugar, acid, tannin, proteid, enzymes, etc. There are several diseases of other plants closely resembling yellows, such as the Serah disease of sugar cane, dwarf mulberry disease, mosaic disease of tobacco, etc., in which the disturbance has been more definitely worked out, and while it is said that yellows is such an enzyme disease, no chemical study of it

has been published other than the fifteen to twenty years old ash analyses, though very complete analyses of healthy peach were published by the Bureau of chemistry in 1905.

Rosette

Another somewhat similar disease known as rosette, found first locally in Georgia some fifteen years ago, is distinguished by the absence of premature fruit (the fruit becoming gummy and falling before ripening), more tufted growth and death after a shorter time five months to two years). It has since been found in South Carolina, Alabama, Oklahoma, and in 1901 in Missouri. The past summer, I found that it had killed most of the peach orchards about Manhattan, Kansas, where, 15 years ago, it was confined to one or two orchards. I also found it along the Kansas valley as far east as Topeka and extending up the Blue river, possibly into Nebraska. I may say that some nurserymen are obtaining pits from this part of Kansas, in the belief that this is out of the limit of the infected district.

Little Peach

Little peach is in some ways a similar disease characterized by the fruit ripening late and very small, the foliage being small, yellowish or red and inclined to roll, the tree dying in two to three years. When the wiry shoots which are sometimes produced as in yellows are present and the fruit absent, it cannot be distinguished from the latter disease. It was first reported from Michigan in 1896 and has since been found in New York, New Jersey, Connecticut (?), Delaware and possibly Maryland. No cause has been discovered but it seems to be contagious.

The occurrence of this disease along the northern border of the yellows region and the rosette along the southern border would suggest that these three diseases which can with difficulty be distinguished at certain times, might be climatic forms of one disease, though one would hardly be rash enough to add such a theory to a question already overburdened with theory.

A suspected case of little peach reported from New York was found to be due to imperfect fertilization, the pit being small and without kernel.

Injuries by Low Temperature

A number of peculiar peach troubles are to be attributed to winter injury and perhaps low temperature is associated with more than

have been assigned to such a cause as the peach is especially sensitive to cold. In cases of collar-girdling, root-rot, stag-head, poor growth and yellow foliage, one should look for the darkened wood due to severe cold which may kill it up to the cambium without destroying the latter. A great deal of trouble of various character at the base of the tree may be due to cold. In a large number of cases, which I saw several years ago in Maryland and similar instances mentioned by Clinton in Connecticut, the root, or the bark at the base of the stem seems to be injured while the top is left in fairly healthful condition. Whether we are right in attributing this to winter injury I am not certain. In some low land near sea level, I had thought that salt water overflow might have been the cause, but the Delaware Experiment Station reports benefit from such a case (1895) rather than injury.

I have noticed in Maryland associated with these basal injuries, an abundant fungous growth resembling the *Cytospora* noted by Stewart as occurring with dead or dying peach in New York, and causing white flattened shot like bodies under pimples. Its parasitism has not been determined.

Frost-crack, body-blight or sunscald seems to be due mostly to extremes of temperature in late winter and spring. Trees making vigorous growth are said to be injured less than old or young trees, and freeze more easily than the middle aged.

Failure of Young Trees

Young trees when set often refuse to grow. Some of this may be due to methods of planting or soil conditions. But I attribute a great deal of it to drying or freezing of the root during the winter storage, in shipping or while planting. Warren has made some tests in New Jersey of the effect of exposure of different duration and found that roots exposed to evaporation for one hour were severely injured.

In speaking of storage troubles, I may mention the fatal fungous trouble (species not identified) found in New York in 1900 where sand was thrown over the stock in the cellar.

Dwarfing and poor growth or early failure may result from grafting upon plum or other stocks that are soon grown over by the more vigorous peach.

A yet unexplained condition found to be causing much loss in several Maryland orchards the past year, in which the base of the stem is swollen, soft and cracked and the main lateral roots are cut off by a regular abscission layer, may be due to partial drying out of the root.

Spray and Other Chemical Injuries

There are still some unsolved problems connected with injuries from copper, arsenic and other spray materials, the peach being especially sensitive to such, though much has been cleared up by Bain and others. Some peculiar physiological disturbances come from the use of oils, and much injury resulted especially in the old days of kerosene and crude petroleum spraying for scale. I do not know of any one having yet worked out the physiological effect of oil upon trees or upon fungi. Whether the peculiar rough bark often seen on peaches sprayed with oil is due to the latter or to recovery from scale I cannot say.

Some of our mysterious troubles may be due to dipping in oils or other materials. Close (Delaware) found severe injury to peach dipped in crude petroleum and more when dipped in kerosene. Symons (Maryland) found injury from oil dipping in some cases. He found more injury when roots were dipped.

Silver Leaf

A condition of peach foliage called silver leaf due to unknown causes has been known in England for years and is reported as serious and contagious. A silvery appearance is common on peach leaves in autumn in this country. I was told by Professor A. L. Quaintance in 1901 that this was due to the work of a mite, but I can find no publication on this trouble except the description of the silvering mite by Banks in 1905.

Split Pit

Split pit is a common and not definitely explained condition. In England it is attributed to excessive and unequal growth of inner and outer parts of the fruit due to rapid growth at fruiting time. Piper says that in the western United States twig borers are the cause of some of it. Another writer says these only enter the previously split pits. It was noted as serious in California in 1904.

I shall now mention some conditions due to various causes, which we may best group under their most noticeable symptoms.

Root Rot

Frequently trees blossom out then stop growing or make an unsatisfactory growth and then die. In such cases the root is often full of fungous mycelium. Several fungi (for example, *Clitocybe parasitica*), (Missouri and Oklahoma) and other Basidiomycetes

(California), *Rosellinia radiciperda* (New Zealand), Ozonium, etc., have been assigned as the cause. Some of the observed fungi undoubtedly follow previous injury by low temperature, wet soil, or other causes interfering with root respiration. Even the undoubted parasites may be assisted in their attack by such conditions. Selby found it more frequent on clay soil in Ohio. It is a common trouble in Oklahoma and Texas.

Gummosis

The ordinary cells of the peach are easily transformed into the gum commonly found about injured peach tissues. Gummosis usually begins in some wound where gum forming enzymes develop and may bring about extensive degeneration. Bacteria (see work in U. S. Dept. Agriculture and Brzezinski in Compt. Rend. 1902) as well as several fungi have been found associated with gummosis and in some cases definitely causing it. It is usually to be looked upon as the indication of some other trouble and may be associated with brown rot, borers, bark beetle, scale, excess of nitrogen, and especially frost, which often leaves patches of bark separated from the wood where the gummosis enzyme starts to work.

Cankers, Knots and Constrictions

Cankers may be formed by various peach fungi keeping open wounds which the tree is trying to heal. Constrictions indicated by the yellow, rolled foliage from uncut bud-wrappings, label wire, etc., are often seen. I have seen a few cases like the above where the constriction was due to the killing of the bark which was dried to the wood and covered with small pycnidia filled with Pestalozzia like spores. Other causes are: overgrowing the stock as when grafted on sand cherry and American plum, attacks of *Phoma persicæ,* other fungi, etc.

A knot of swelling of twigs is described by Selby in Ohio (1898), clubbed branches noted by Erwin Smith (1892), a tuberculosis attributed to a species of Clostridium occurs in Europe, MacOwen reports at the Cape of Good Hope (1899) knotlike growth followed by death of the twigs bearing them, and a case of swollen and blistered peach trees in England is reported in Gardeners Chronicle 1897.

Shot Hole and Leaf Spot

The cause of the Shot hole effect in leaves may be difficult to find as the affected portion is cut away by the peach itself. Spray injuries

and various fungi, such as *Cercospora circumcissa, C. persicæ, Phyllosticta persicæ* (in Maryland last summer), *Macrosporium commune* (Michigan), *Bacterium pruni*, etc., have been noted as causing these troubles.

Chlorosis

Aside from the yellowness of foliage mentioned already under yellows, etc., a yellow foliage condition is well known in Europe under the name of Chlorosis.

Powell (Delaware 1897) reports a case of yellowish willow-like shoots, from newly budded stock, identified by experts as yellows, but which disappeared as the trees grew older. He attributes it to influence of the bud and weather conditions causing late growth. These yellows-like shoots are often seen in nurseries and when older trees have been severely pruned, or when growth has been checked by grafting, bending, or constricting a branch.

Following the excessive wet spring of 1909 in Kansas, I noticed that the foliage at the ends of many peach branches as well as on other species was almost white. Selby attributes to wet soil, a variegated foliage with yellow along the veins, seen in Ohio; and Stewart and Blodgett report a condition with watery edge to the leaves, later becoming yellow and passing into tip burn; cause unknown.

Leaf Roll, Wilt, Leaf and Fruit Drop

These conditions may be due to various troubles, girdling by borers, wire, winter injury, dry or stony soil (see Johnson's frenching disease, Maryland 1896) or even to wet soil, in addition to such diseases as yellows and little peach. Wilting due to unknown causes has been mentioned by several writers.

A bud dropping disease (cause unknown) is reported from South Africa and similar troubles in English greenhouses are attributed to improper ventilation.

The June drop has been rather a mystery but probably is as Waugh says due to combined action of nonpollination, curculio and the struggle for existence.

Prematuring of Fruit

This may be caused by yellows (in which case it is distinguished by the peculiar red spots) by borers, or by girdling in other ways.

Twig Spot

The well known grayish, purple bordered twig-spots seem to be due to the fruit scab fungus. I found similar spores developing from them last spring (See Duggar, Fungous Diseases). Stone and Monahan mention a twig-spot due to a Monilia.

Twig Blight, Staghead or Dieback

The cause of death of branches is so varied as to be extremely confusing. I may mention among fungi: *Phoma persicæ, Sclerotinia fructigena, Valsa leucostoma, Coryneum beyerinkii, Næmospora crocea* also old age, poor soil conditions, yellows, spraying mixtures, oils in particular and probably some lime sulfur, cold weather, etc.

Fungus and Insect Troubles

Many diseases due to vegetable parasites have been pretty well cleared up: such as crown gall, brown rot, leaf curl, bacterial leaf spot, fruit scab, frosty mildew, California blight, powdery mildew, rust, and fruit rot due to *Glœosporium læticolor* and *Aspergillus glaucus*. But among these and others many points in nomenclature, pathology and treatment are yet unsettled.

It is hardly worth while to mention the large list of other fungi given by Saccardo as occurring on peach but not mentioned in recent pathological literature. But many of these occurring even on dead tissues only may be stages of active parasites which are yet to be worked out.

The many disturbances due to insects and other animals, I shall not mention, as they are out of my domain except to say that in addition to the simple injuries they cause, definite diseased conditions are due to nematodes, San José Scale, borers, curculio, root aphis, etc.

LOCAL INSPECTION, PUBLIC SPRAYERS AND THE OSAGE ORANGE HEDGE

By Thomas B. Symons, *College Park, Md.*

Mr. President and fellow members:

The title of these remarks would seem to indicate a rather elementary discussion to present to this Association, yet it seems to me that we should not lose sight of these practical problems with which each of us come in contact in the performance of our several duties. There

is no doubt that much practical information has accumulated as the result of comparatively recent investigations throughout the country, that has not as yet reached the men or farmers in whose interest the work was undertaken. I, therefore, consider the proper dissemination of facts already known to those who need the information as important a problem as the seeking of new facts looking towards the mitigation of many existing troubles. Moreover, as professional men, I consider that we should aim as far as possible to stimulate means whereby our theoretical instructions, so to speak, may be put into practice. The mere fact of advising a grower what he should do in order to relieve a certain condition or save a certain crop is not sufficient. It is somewhat similar to a doctor prescribing a medicine that cannot be procured at the drug store within a reasonable time or without a great expense.

The third subject of my title is one in which as inspectors, we should be especially interested and as men seeking to improve the economic status of our constituents, we should spend every effort in conducting an interstate campaign towards the elimination of this constant menace to our farmers and fruit growers.

With this introduction, I shall discuss briefly these three subjects, giving our experience in Maryland with the desire to stimulate further discussion by the Association.

Local Inspection

Upon the enactment of the Maryland Inspection law, the officers charged with its enforcement found difficulty in disseminating the desired information to the mass of growers as well as in getting amicable and practical compliance with the law by negligent orchardists.

It was apparent that the orchards of the state should be inspected both for the benefit of the growers as well as to do justice to the nurserymen. It was difficult, however, to devise means for a proper inspection with the limited funds at our command. For a time the officers of the department endeavored to visit as many parts of the state as possible, but this procedure, while being of great assistance, did not promote the work as was desired. There was needed a farm-to-farm canvass to ascertain the real conditions. It was then decided to appoint a practical man in each county to conduct the local inspection of the orchards. This system of orchard inspection has been in operation in Maryland for the past eight years. The local inspectors are given a short course free of charge at the college during the winter. The course covers the identification and means of control of the

common injurious insects and diseases and up-to-date methods of orchard management. The inspection is conducted during July, August and September. Each inspector is given an alloted territory by election districts. He is required to plat each orchard on a topographical map of the state as shown by exhibit I. He is also required to make a report of the inspection of each place on the blanks, exhibit II., and directed to leave a card, exhibit III., at each place inspected, which serves to notify the owner or tenant of the inspection, if he should be away at that time. Each card is supposed to be filled out and sent to the office by the grower, who states what he has done or will do in the near future to comply with instructions. I may add that upon the receipt of the reports from the inspectors, we communicate with the growers in regard to the conditions of their orchards.

This system has given much satisfaction in Maryland; our only difficulty is that our funds only permit the inspection of about twenty-five per cent of the state during a season, and we are not able to reinspect this territory within a reasonable time to ascertain the existence of neglected cases and enforce the law, where necessary.

The important aspect of this work that I wish to point out is, *that there is no doubt that the personal contact method of dispensing information is the best means of reaching all growers.* The local inspectors are enabled to have personal interviews with the growers in their own orchards, where they can point out such insects or diseases as may be affecting their trees; suggest proper culture methods and give in a practical manner such information as they need. Moreover, by this system, we are enabled to reach many farmers who may grow a few trees, and orchardists, who may never attend farmers' meetings where such subjects are discussed. Further, the local inspectors can explain the work of the department to the orchardists and show them that our efforts are directed toward helping them in the protection of their trees and in production of good crops, rather than in seeking enforcement of the law.

In my opinion, the extension work of the departments of our colleges and stations, and State departments could well adopt such a plan for disseminating other agricultural information. A visit of a good practical man to many of our farms, spending two or three hours or longer with the owner would be of much greater service to the farmer than many bulletins on the different subjects that may be thrown into the waste-paper basket. The farmer wants practical information and most of them are from "Missouri." The conditions at each place are different, and what would be a good suggestion in farm management for one, may be entirely useless or undesirable for another.

Public Sprayers

In the course of our work in Maryland for the control of the San José scale, we found great need of public spraying outfits in various parts of the state, especially in localities where fruit trees are grown by the farmers for home use only, and around our cities, towns and villages, where a few trees only are grown by suburbanites for the same purpose. Among this class of people there is not sufficient interest at stake, ordinarily, to justify their procuring spraying apparatus with which to properly treat a half dozen or so trees, but they are usually eager to have their trees healthful and willingly employ a public spraying outfit to treat such trees effectively.

It is not an uncommon occurrence to observe every fruit tree growing in some towns or villages badly infested with the scale. In order to aid this class of growers by furnishing means whereby they can have their trees treated and to demonstrate the field for a successful business to the end of inducing private parties to take up the work, our department has conducted public sprayers in different parts of Maryland for the past two years. The past season, twenty-five outfits were operated. A responsible man was secured to superintend each outfit. The spraying was conducted on a basis of cost of operation and not with any desire to make a profit for the department. The past season, the concentrated Lime Sulfur Solutions were used, which greatly facilitated the work.

The venture has been a great success in our state. In each locality where an oufit was operated, there has been more work than could be accomplished prior to the opening of the buds in the spring. This year, two of the outfits continued operations by spraying for the control of the Codling Moth.

Aside from offering immediate relief in saving fruit trees that would otherwise have been killed by the San José scale, the inauguration of this work has accomplished in many instances the principal object for which the work was undertaken. It has shown that there is an opportunity for such a business which will give a reasonable profit where properly conducted. As a result there are many private parties who will conduct public sprayers in Maryland during this coming season; in fact there are some who have done considerable work this fall.

I believe that we, as inspectors and professional men, should aim to develop means whereby our recommendations can be most effectively put into practice. There is no doubt that the operation of public sprayers and the conducting of public spraying demonstrations on the

Alms House farms and in other selected orchards, showing the actual results that can be secured by spraying for the Codling Moth, has accomplished more in stimulating an interest in and popularizing the work of our department in Maryland than any other work that has been undertaken.

The Osage Orange Hedge

I am unable to give actual data as to the general distribution of this hedge plant, but it can be stated, that it is commonly employed as a make-shift fence in the Central, Middle Atlantic and Southern States of our union. Perhaps it is more abundant in Maryland, Delaware, Pennsylvania, Ohio, Kansas and adjoining states than in many others where it is occasionally seen. The plant is indigenous from eastern Kansas south through Arkansas and northeastern Texas, and throughout the prairie regions of the Mississippi basin. As to its occurrence in Maryland, I may state from actual observation that it may be seen in any part of the state but four counties particularly are badly afflicted with this nuisance. In these counties there are undoubtedly far more miles of hedge than county roads. It is rather peculiar that in those counties the fruit interests are far more predominant than in other counties of the state. In many instances, this is practically the only fence on the farm. It thus serves as a division fence between farms, as well as a supposed barrier for farm animals between fields.

The Osage Hedge furnishes an abundant food plant for the San José scale, and as this pest is generally disseminated over the central and eastern parts of the state, it follows that practically every hedge is infested to a greater or less extent; in fact I have not observed an Osage Orange hedge that was not infested with scale. This condition is no doubt true in other states where the two nuisances occur. Unfortunately, the plant is so vigorous that seldom will the scale kill it outright. As hedges offer especial opportunity to the agencies which aid in dissemination of the pest they will serve to infest fruit trees considerable distances from them.

As inspectors, we should be particularly interested in treatment or destruction of the Osage hedge, only as it serves as an important and widespread food plant for the San José scale. However, the hedge may be condemned for other economic reasons, as follows:

First. That seldom is there seen a hedge that will serve as a proper fence. If it serves as a barrier to horses and cattle, it will contain holes, permitting hogs and sheep to pass through, and as a whole may be considered worthless in barring our domestic animals.

Second. While repairing is from time to time necessary, it is seldom practical. This expense added to that of trimming the hedge every year to keep it in a presentable condition, is more than enough to effect the cost of erection of a good wire fence. The hedge should be given one or even two or more trimmings each season. This is an expensive and very disagreeable operation principally on account of the thorns.

Third. The Osage Orange plant is a very vigorous grower, its roots permeate the ground on each side of the hedge for at least ten feet and in many cases greater distances. It thus robs the soil of fertility and moisture that should be accessible to crops planted in the field.

There are, therefore, several vulnerable points of attack, in fact the majority of those who keep Osage hedges recognize it as a general nuisance, but aside from the natural reluctance to lose the first cost of the plants and perhaps many years of expense in maintenance, the expense of grubbing up the hedge and the setting of a new fence is in the majority of cases the only excuse for their existence on so many farms.

In Maryland the department has adopted the policy of allowing the farmers three years in which to rid their property of this nuisance. Thus the hedge bordering on the fields to be cultivated each season can be destroyed. This method will not work a hardship on the owner or tenant, and it is hoped that it will serve to gradually eliminate this important food plant of the San José scale, and otherwise expensive make-shift for a fence from Maryland farms.

It seems to me that a widespread campaign may be waged by the inspectors of the several states in ridding our country of this most troublesome hedge plant.

DISCUSSIONS OF QUESTIONS ON PROGRAM

PRESIDENT: Question Two: "What means can be taken to require the railroad officials to be more strict in demanding certificates when accepting nursery stock for transportation?"

If there is nothing special to be said about this matter, we will pass on, as the railroad officials are very willing to coöperate with the inspector, and I believe have always sent notices of stock received without certificates, or have held the stock, or refused to take it, because it was not accompanied by a certificate.

MR. SURFACE: Notifications of the receipt of foreign stock, however, sometimes do not reach us until the goods have passed through

their freight offices, and the shipments cannot therefore be followed up. These people hold the papers in their office until they have several, instead of forwarding them at once to us. They do not seem to realize the importance of mailing these reports immediately, when shipments pass through their office.

The Secretary of Agriculture of Pennsylvania took this matter up and went to the headquarters of the Pennsylvania Railway Company, and since then we have been notified more promptly.

MR. ATWOOD: We have had something over two thousand reports from transportation companies, and we have had very little complaint to make in regard to delays in mailing the same. We have sixty odd transportation companies with whom we are in correspondence and we agree upon the necessity of prompt reporting, and have in various ways secured the promise of their coöperation, so that the thing is working out very smoothly, for all purposes.

PRESIDENT WASHBURN: Question Four: "Are scale marks to be considered prima facie evidence of infestation?"

MR. GILLETTE: Until this last year we received some little stock that showed signs of this scale; now we are finding a considerable number of shipments containing scale marked trees. In Colorado it is a matter of keeping the insect out of the State.

MR. ATWOOD: We destroy all stock with live scale upon it, and nurserymen are very willing to destroy any trees with scale marks upon them, as their presence is a distinct injury to their business.

We take that stand, because as a rule the nurseryman, as well as the buyer of the stock, will refuse to buy it, if scarred. We never take trees and fix them up for sale. I don't think that has ever been done in the State of New York, and the nurseryman will not handle trees marked with scale, and if received they are returned direct to the shipper. It is necessary for our inspectors sometimes to stand between the nurserymen and the fruit growers.

We all know that trees will show scales, whether they have been treated and fumigated, or not. The nurseryman does not want to arouse the suspicion of his customer, and therefore this is a proposition with which we have nothing to do in our department. The department takes the position that anything with live scales on it must be destroyed.

We have requests received from inspectors in some of the other states, asking how long after a tree was fumigated, it would be in a condition to be sold. How long will a scale retain its freshness and color after its fumigation?

Mr. Hitchins: I have had letters asking the same question, from men, and have replied that we would not take such trees at all.

Mr. Heusted: I have had an experience which I would like to relate to you. We have had an opportunity to experiment on a shipment coming from another state. The scales were of an olive color and were dry, but we failed to find a single live insect. When one of these trees was examined the following July, however, we discovered a few young lice on it.

President Washburn: Question Five: "Should not nurserymen be required to fumigate all buds and cions and by what formula?"

Mr. Atwood: Some of our nurserymen are obliged to fumigate cions in New York. Cions are fumigated with full strength. I know of one nurseryman who has made a practice of fumigating all of his buds with the full strength formula, allowing fifteen to twenty minutes exposure, and no damage whatever was done.

Now, there is no objection to the nurseryman fumigating his buds, and there is every reason why he should, because the scales are likely to be attached just under the buds.

A man can go into an orchard and get his bud sticks that are infested, and thus introduce the scale into his nursery. I have seen many cases of this kind.

My impression is that fumigation can be successfully used to kill the scale on the buds. Old trees might not be affected by fumigation, but there is some question as to whether a twenty minute exposure during the summer would not result in disaster to growing buds.

President Washburn: Question Nine: "What shall be done for the owner after his orchard is inspected?"

Mr. Surface: We give the orchardist a written report as to what the inspector finds, telling him what pests are found on the trees, a duplicate of which is sent to my office, and at the proper season for treating these pests, we write him again, lest he forget, and tell him that this is the time the pests are to be treated, and also what to do for them. We tell him, also, that if he has a spray-pump, we will send our inspector to his orchard, if he desires, to instruct him in regard to the use of the pump, the only charge made is for the local transportation to and from meals and lodging.

President Washburn: Question Twelve: "Shall there be legislation against selling fruits infested with San José scale and the Codling Moth?"

A Member: I might say that such a law might be the best thing for fruit growers, as it would keep infested fruit out of the market.

It would be the very best thing that could be done,—yet they would resent it.

MR. HITCHINGS: At the New England fruit show held in Boston a few weeks ago, some of the prize apples that were awarded the blue ribbons were badly infested with San José Scale, in spite of the fact that the judges were experts on fruit.

I would like to know what to do with infested fruit. I had one person write me, asking if I thought it would hurt him if he ate a San José Scale. I told him I thought he would survive.

MR. GILLETTE: It seems to me that fruit marked with this scale should not be allowed on the market.

PRESIDENT WASHBURN: Question Thirteen: "What are the arguments in favor of inspection and the control of peach yellows and little peach?"

MR. HEUSTED: I suggested this question, as I would like to have some one else's opinion on it.

MR. TAFT: Up to the last year or two, I had seen only one nursery tree which showed signs of disease, but I have seen trees this year which have come from nurseries and were put out in the spring, and showed symptoms before the season was over.

MR. ATWOOD: In our experiments in New York State, we are going to keep watch on this point, as we are all very much interested in it.

Some six years ago we took about ten square miles and attempted to control the peach yellows, and by ordering the trees which were infested taken out annually, the number of diseased trees in that area has gradually grown less.

MR. WILLIAMS: Regarding the question of securing the best pits for the various nurserymen: Our people secured most of their pits as I understand it, from growers in North Carolina.

It is a question as to whether it is a disease in some particular climate or zone, or some particular section. Should a man cease from getting his pits from North Carolina?

MR. GILLETTE: In Colorado the peach yellows has never been known in our peach section, although watched very closely.

MR. WORSHAM: The yellows are liable to develop after the trees are a year old. Professor Phillips has been working with his nurserymen for the past two years, and insisting that they buy their pits from the southern growers, and we have made many inspections of orchards from which pits were taken to be supplied to Georgia growers.

I know Georgia orchardists have supplied a great many pits at Professor Phillips' suggestion.

On the other point, we are not in a position to say.

Professor Scot at one time was of the opinion that the yellows would not spread in the far South, and for a great many years some of the growers carried stock from the East down into Georgia, but we have never found a single case of yellows.

Mr. Surface: I would like to call attention to an article by G. P. Clinton in the Connecticut Pomological Annual Report for last February, in which he discussed peach yellows, and brings out most important facts. I would suggest that we cite these references, as oftentimes a man is too busy to read every article in the magazines, and that would be the best way to keep in touch with what is going on.

Professor Taft: Our experience in Michigan does not give us reason to think that the disease is to any great extent influenced by climatic conditions except that the disease generally seems to be most virulent, or the trees are perhaps more subject to attack, when they have been weakened by a severe winter or other unfavorable climatic conditions. The disease itself is unquestionably of a contagious nature for although peaches are grown quite extensively in thirty or forty of the Michigan counties, yellows was for the first ten years after its appearance in Michigan confined to a single county although the conditions there were not unlike many of the others.

From this county of Berrien, which is in the southwest part of the state, the disease spread gradually to the north and east but in forty years has not advanced more than 100 miles.

Had there been much danger of the spreading of the disease through nursery stock, it would have unquestionably broken out in every county in which peaches are grown but the fact is that it is unknown in fully one half the counties of the state and, at the end of twenty years after it was first noticed, it had not appeared in more than a half dozen counties.

Mr. Hitchings: In Maine, we have had to do away with the climatic theory maintained in the Connecticut article. We have had for the last few years a great increase of yellows, and the point of the argument is: "Is not this influenced by climatic conditions?"

It has been the feeling among many of our inspectors that the discussion of this article has been inclined to prove that the yellows was due to climatic conditions. The results, however, do not agree with some of the previous work done by Irwin F. Smith.

A Member: Two years ago some fruit trees which were infected with this disease bore premature fruit and this year they bore perfect fruit.

Professor Taft: I have seen premature fruit which was rather

red around the pit, which was due to a very hot season or to borers, but that coloration is not characteristic of yellows.

PRESIDENT WASHBURN: Question Fourteen: "Should the sale of premature peaches be prohibited?"

MR. WILLIAMS: This is a question of importance to many growers.

MR. TAFT: Our law requires the destruction of premature fruit, and it has been carried out. It has the effect of securing the proper destruction of infested trees.

Usually owners are not inclined to cut them out, but, with this law, we have been able to have the trees promptly destroyed.

A MEMBER: In some states the growers desire to harvest the crop before destroying the trees.

MR. TAFT: We do not take that into account and so far as we know the disease does not spread during that period of the year, but if these growers were allowed to gather in the fruit and sell it, the trees would not be promptly destroyed. If the fruit cannot be sold, they will cut them out.

PRESIDENT WASHBURN: Question Fifteen: "What is the present status of the Crown Gall on apple? How is such considered, in issuing certificates?"

MR. WILLIAMS: In Alabama there is a question whether there should be an allowance for oversight. A great many times the owners of nurseries are not able to determine personally whether all trees are free from Crown Gall.

Now, there was one order delivered, where we found between 2 per cent and 3 per cent of the trees infested with Crown Gall, and according to the law, the nurserymen are required to destroy them.

In some states they allow 2 or 3 per cent for oversight. Every man cannot personally look after his stock.

A MEMBER: If I have been wrong regarding this phase of inspection, you will kindly let me know your opinion.

One of the very largest nurseries noticed a large amount of Gall on raspberries, and I was very certain of the disease. I sent some of them to Washington to confirm my diagnosis, and it proved to be a very bad case of Crown Gall.

I sent them the certificate with the words "Contagious Diseases" left off, so that they have a certificate allowing them to ship stock. It would have caused a row; a very big row. These people are morally convinced that Crown Gall is not injurious.

MR. ENGEL: Destroying the infested trees is the only measure we have taken thus far, although we have to keep the trees from being shipped. Recently a consignment of apple and peach trees came to

Harrisburg which I personally inspected. Fully 15 per cent were rejected outright, and fully 40 per cent of the balance showed marked symptoms of Crown Gall, and were only accepted on condition that the consignee would not sell them, but use them experimentally for his own planting. The balance were accepted and while some of our scientists do not attach much importance to the disease others do, and I would prefer not to plant them myself. I would be glad to know the opinions of the members present as to what they would have done in this case. There is considerable trouble and we must in a measure depend upon the care and honesty of the nurserymen, as there is usually no indication of the disease apparent before digging.

President Washburn: I would not, I think, under the circumstances, refuse him a certificate; yet, I would expect him not to send me any more trees of that kind, as all trees I would expect to be free from diseases of any kind, and I would also make him understand that I was giving him the certificate with the understanding that he would reject any trees found with Crown Gall.

Mr. Worsham: There seems to be a good deal of division along that line, and this Association ought to go on record as to whether we should or should not give certificates in cases of this kind.

Mr. Gillette: In Colorado the fruit growers despise Crown Gall as much as anything that comes into their orchards. If you come across a stunted tree, you will find if you investigate that it is infested with Crown Gall. Last year one of the leading nurseries in the state shipped more than one hundred thousand trees into another state, and a large percentage of them contained Crown Gall, but we have not received any with Crown Gall, to our knowledge, yet.

A Member: Concerning the statement made by Mr. Engle: I believe I should have allowed him to keep the trees, after destroying the 15 per cent, but I would also have made him promise to plant them himself, and not sell them to his customers.

Mr. Summers: My own feeling for several years has been that the Crown Gall was really one of the most serious nursery problems with which the inspector has to deal. There are several distinct aspects of this problem which should be considered. One is the propriety of giving a certificate to a nurseryman on whose grounds Crown Gall is found. I know that our certificates do not always say exactly what they mean. I will say frankly that if I did not give certificates in Iowa to any nurserymen excepting those whose stock is entirely free from Crown Gall I would not issue any certificates. I am speaking here, of course, of general nurserymen who grow apple trees, not of those growing only ornamentals or berry plants. I cannot help

agreeing with what was said by the gentlemen from Colorado. I have been studying this problem for a good many years myself in Iowa.

We have Crown Gall in a good many orchards. The Crown Gall trees do not average in bearing qualities anywhere near the average of the other trees. It is possible for those who are familiar with the effects of this disease to go through an orchard and pick out with a fair degree of certainty the Crown Gall trees. Now the important question is, what are we going to do in controlling this disease? It is quite one thing to say that I, in Iowa, for instance, will require nurserymen to agree to destroy all Crown Gall trees at digging time, and quite another thing to see that this rule is carried out. I have not been entirely consistent in my policy in regard to this. I cannot help regarding it as little more than a mere form to give a certificate and at the same time require an agreement from the nurseryman that he will destroy the Crown Gall trees. The honest nurseryman does not need to have that statement required of him, and the majority of them are honest. The dishonest ones will not respect it. Here is an example of the way this policy works out. One of the oldest and most reliable nurserymen in Iowa was taken ill just before the spring shipping season, with pneumonia. He had been warned that he had more Crown Gall than usual. His foreman had a slight interest in the business, and before we knew it he had sorted out a lot of Crown Gall trees and shipped them to a nurseryman, a dealer, who was going to resell them. I happened to be at that dealer's grounds by accident when the consignment of trees arrived, otherwise I think it probable that they would all have been delivered to customers. This raises the question as to how many Crown Gall trees are being shipped in other places by the employees of nurserymen without the personal knowledge of those nurserymen. The grower above referred to was not personally responsible. He had given proper directions and he was too ill personally to superintend any business. In very many cases large nurserymen are obliged to depend on men who cannot be kept up to the standard the nurserymen would wish. What are we going to do in such a case as this?

Now, I would add in closing, that I think this Crown Gall problem is one which we should do our best to take care of. A nurseryman asks us to inspect and issue a certificate on his stock. We may know that he is doing all that he can to keep this disease out of his nursery, nevertheless, a good deal of Crown Gall is found. He naturally calls upon us for directions as to how he can grow clean stock. If we are to refuse him a certificate because of the presence of any disease it seems to me that we should be able to give him more than a few

vague hypotheses as to the methods by which he can eradicate that disease.

S. J. HUNTER: It seems to me that we have arrived at a place where we may properly ask the question: What part can this Association take in dealing with such cases as the one under consideration? It would seem pertinent to ask, Can this Association standardize the work of the inspectors in the various states? It is generally conceded that the Crown Gall may be found wherever apple stock is grown. The gentleman from Iowa has given proper expression to this phase of the subject. There is some difference of opinion regarding the injurious effect of this crown gall, but the majority, I believe, look upon it as highly detrimental to the life of the host. Crown Gall in the more advanced stages is more readily recognized and therefore does not pass as readily as some of the subjects of quarantine. The issuance of a certificate, with the understanding that the recipient will cull out all the Crown Gall, is a common practice, although by no means a satisfactory one. It seems to me that it is time for us to consider inspection both at the nursery grounds and at the point of destination.

MR. J. L. PHILLIPS: We have done a great deal of work on Crown Gall for five or six years, and we have found, almost invariably, that trees affected by Crown Gall may grow fairly well in the orchard during the first year or two, but will die before many years. They simply rot off and die. The nurserymen have had a great deal of trouble of late years, as some trees in consignments are found to have Crown Gall, while the majority are all right, and we do not feel like discarding them, unless absolutely necessary.

We realize, also, that this is one of the most serious troubles with which the nurseryman has to deal, and we have given a good deal of thought to it, and conducted many experiments.

We noticed that scions from trees affected with Crown Gall would produce diseased trees. Forty to 60 per cent of our experimental trees were affected by this disease where scions were cut from diseased trees.

If you get scions from healthy trees, you will have little or no trouble. We had an opportunity to make observation during the past two years in quite a large number of trees in a new nursery.

The scions came principally from old orchards. A large percentage of the trees are in the nursery at the present time, but of those taken out last fall only about from 6 to 9 per cent were affected with Crown Gall.

Our present understanding of the matter is that scions cut from trees diseased with crown gall will transmit the infection into trees

grown from them and that scions cut from healthy trees will produce healthy trees.

We had an opportunity to observe a very large number of trees during the last 5 or 6 years, and in this nursery, in particular, some 40,000 trees were under our observation. In practically every case where the scions were cut from the tops of diseased trees, they produced Crown Gall.

It looks to me as though, if 50 to 60 per cent of the trees in a nursery are affected with crown gall, the entire lot should be destroyed, but until nurserymen have had a little more time to get their nurseries in condition, this would be rather drastic. These questions, as well as transmission of peach yellows and measures of control in the nursery are discussed in my report now in press.

This concludes the Proceedings of the meeting.

J. B. Symons,
Secretary

Scientific Notes

A Typical Name for the Friend Type of Nozzle.—At the meeting of Economic Entomologists in December, 1910, there was more or less confusion when speaking of a comparatively new type of nozzle. As no general name has been decided upon, the maker's name has usually been given this nozzle, such as the Friend, Myers' Power, Deming, etc. It is so distinctly different from the Bordeaux, Vermorel and other types that I would suggest the name Disc. The feature of the nozzle is the disc, which is found at the outlet and regulates the spray.

This type is being used very extensively and is a great improvement over the old nozzles. The name disc describes very simply the main feature and can be generally used in such a way as not to show any partiality to an individual dealer or manufacturer.

Should this suggestion meet with the approval of the Economic Entomologists, might it not be well for all to adopt the same name?

H. L. Frost

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1910

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints may be obtained at cost. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—EDS.

Recent years have witnessed a marvelous increase in our insecticide batteries. Some of the newer or quicker acting materials or preparations have already been sufficiently tested and have either been discarded as worthless or otherwise accorded a suitable place in our defensive campaigns. Last year we were confronted with statements of injuries to fruit trees in the west by arsenical poisons. Other investigators have denied the sufficiency of the data to prove the thesis, and have attributed the trouble to other causes without, so far as can be seen by the uninitiated, adducing more convincing evidence in support of their position. It is to be regretted that the latter parties have not yet been able to make or at least to publish the results of careful studies from the chemical standpoint. The problem is too large to be disposed of quickly, and too serious in its potentialities to be ignored. Every possible factor should be the subject of careful investigations, even though a final solution is not reached within a decade. There is a grave question as to whether we are yet in position to discuss the ultimate effect of adding to orchard soils, annually, quantities of a partially soluble arsenical compound. It should be remembered, that spraying with poisons is comparatively new. The effect upon the soil of repeated insecticide applications, should be well considered before the use of any material is advised as a part of the regular orchard management. It seems timely to at least raise a doubt as to advisability of using large amounts of poison simply to obtain results quickly, unless the latter are necessitated by peculiar local conditions. We would suggest for the present, placing more emphasis upon thoroughness in an endeavor to secure the maximum benefit with a minimum application.

Reviews

A Monographic Revision of the Twisted Winged Insects Comprising the Order Strepsiptera Kirby, by W. Dwight Pierce, Smith's Inst. U. S. Nat. Mus. Bull. 66, p. 1–232, 15 pls., 1909.

In this important monograph Mr. Pierce has included practically all that is known concerning the peculiar parasitic insects of the order Strepsiptera. The work contains a detailed account of the systematic relationships of these insects, of their relations to their hymenopterous and homopterous hosts, their effects on these hosts, their taxonomy and geographical distribution, a list of all the known species and a very complete bibliography. He thus presents us with an excellent foundation on which all future students of the group will have to build. To conservative entomologists it will seem that Mr. Pierce has dealt with the taxonomy in a spirit of over-refinement, or preciosity. Accepting Kirby's view that the Strepsiptera constitute an independent order, he seems to feel that he must give this small compact group of highly specialized parasites the status and dignity of one of the larger orders. He therefore divides it into 4 superfamilies and 8 families. He cites 37 genera to include the 109 species; 25, or about two-thirds of the genera, and 40, or somewhat more than one-third of the species being described as new. The desire to fill out an order in this elaborately articulated manner necessarily leads, in the case under discussion, to the use of rather meager characters for superfamily, family, generic and specific distinction, and puts the Strepsiptera out of all proper perspective to the other insect orders. Furthermore, the permanent value of these characters is rendered highly problematical owing to the small amount of material examined, for the Strepsiptera are by no means common in collections. Thus out of the 109 recorded species, only 18 are known from specimens of both sexes, and 10 of these belong to two allied genera. Of the 34 species enumerated in the largest genus, *Stylops*, for example, specimens of 10 have not been examined by the author, 15 are described from single specimens, 4 from two, 3 from three, 1 from four and 1 from five specimens. Some whole genera or even families are based on only one of the sexes. Certainly the meager specific characters utilized by Pierce can have taxonomic value only if it can be shown that they are subject to very little variation. This is impossible, however, with the very limited amount of material now on hand. Whether, under the circumstances, it is better to multiply species and genera and run the risk of sacrificing many of them to a future synonymy, or to proceed very slowly and conservatively, especially when dealing with such a specialized and parasitic group, is a matter on which there may be some difference of opinion. It is certain, however, that the latter method, though it may seem to be more timorous, may have the advantage of not burdening the nomenclature with superfluous names, nor necessitate extensive taxonomic tinkering and readjustment in the future. One of Pierce's reasons for multiplying species is to be found in his assumption that every species of Strepsipteron has its own particular host species. But in *Acroschismus*, of which he has seen more material than of any other genus, this rule breaks down, for *Polistes rubiginosus* is attacked by 4, and *P. texanus* by two species of the parasites, and one of these species is common to both of the wasps. If we accept this postu-

late of very exclusive adaptation of parasite to host, we must assume that the larvæ, or triungulins, which stand but little chance anyway, when they are on the flowers, of getting on to Hymenoptera, have their chances of survival still further diminished by being carried to the nests of the wrong species of wasps or bees. There are also a few minor points which strike the reader of Pierce's monograph as being inadequate or erroneous. Thus the measurements should have been given uniformly in micromillimeters (μ), if they are really as important as he would have us believe. The view that the Strepsipteron, is not entoparasitic. These, however, are slight errors, and Mr. mouth and alimentary tract, as Brues has shown, and there is therefore no reason for supposing that it feeds unlike other entoparasitic larval insects. It is not true that the Strepsipteran type of metamorphosis "is unique among insects," for the reason that "in no other case is there complete endoparasitism," since the triungulin, or first larval stage, even of the female Strepsipteron, is not entoparasitic. These, however, are slight errors, and Mr. Pierce is deserving of great praise for the care and diligence with which he has brought together all the scattered and fragmentary descriptions of the Strepsiptera and for the copious and substantial additions he has made to our knowledge of this extraordinary group of insects.

W. M. WHEELER

Experiments with Powdered Arsenate of Lead as a Practical Boll Weevil Poison, by WILMON NEWELL and G. D. SMITH, Louisiana Crop Pest Commission, Circ. 33, p. 251–333, Pl. 1, 1909.

Two recent publications of the Lousiana Crop Pest Commission furnish the most important data thus far brought forward concerning the control of the boll weevil, at least as far as its control in the lower Mississippi Valley is concerned. We predict that the results published in these two bulletins will be worth many times the entire cost of the Commission to the citizens of Louisiana.

In Circular 23 of the Louisiana Crop Pest Commission, Professor Newell described preliminary experiments with powdered arsenate of lead as a remedy for the boll weevil, which indicated the practicability of its use. In the bulletin just issued the outcome of practical field experiments is recounted and it is evident that Mr. Newell and his assistants have demonstrated for the first time the successful use of poisons for the boll weevil. There is a long and checkered history of the attempts to poison the boll weevil which need not be rehearsed, but from the account given it would seem that a method has finally been demonstrated which is both effective and practical under prevailing conditions.

The principal field experiments in 1908 were destroyed by floods, but nine acres located at Mansfield, La., showed an increase of 56 lbs. seed cotton per acre from a single application of one pound of powdered arsenate of lead per acre, this giving a net profit of two dollars per acre. This experiment is of interest because on the same ground experiments were made with Paris green in 1907 which showed a decrease of 97 pounds per acre against the 56 pounds increase when the arsenate of lead was used. Two experiments carried on with liquid arsenate of lead showed no benefit resulting.

Several cages were used for making further tests of the effect of powdered arsenate of lead. These were about five feet high covering a single plant which bore about 15 bolls and many squares; 100 weevils were confined in

each cage. The plants in two cages were poisoned while those in the other two were not. Four days after the introduction of the weevils on July 30, fully half of them were killed on the poisoned plants, the most of them dying during the first two days. Altho the effect was not as pronounced as where the weevils were feeding upon squares only, it was so encouraging as to lead up to the extensive experiments of 1909.

In 1909 experiments were carried on at four different points on a total of 95 acres with 12 different plots treated and corresponding check plots. The plots were arranged so as to determine the relative value of from 1 to 10 applications and from 1 to 50 pounds per acre according to the number of times applied. The plots were well laid out to determine these points by comparison with the checks and the number of infested squares on a considerable number of plants in each plot was counted nine times at weekly or ten day intervals. In determining the profit the cost of the poison and the labor was deducted from the benefit derived in each plot. The average production of all the cotton poisoned in 12 plots on 46 acres was 673.8 pounds per acre. The average production on 12 similar plots not treated, a total of 49 acres, was 392.6 pounds per acre; thus the average increase in production was 281.2 pounds per acre or 71 per cent. The tables show the profits on each plot in detail and the profits are so uniform and the benefit on the whole area is so evident as to exclude any possibility of the results not being thoroly reliable. The greatest profit per acre was secured by dusting five times, which showed a profit of $23.54 per acre.

Mr. Newell points out that the fall destruction of cotton stalks is necessary even with this treatment. If the poison kills 75 per cent, and the weevils be excessively abundant, the 25 per cent not killed would be more than enough to destroy all the squares. This is evidenced by an experiment at Woodside, La., where there was an unusually heavy infestation in 1908 and no cotton was grown in 1909 except on four acres specially planted for the experiment, upon which the weevils were concentrated, there being 5 to 8 weevils per plant at the first poisoning. Were it not for the poison the crop would have been totally destroyed. As it was the weevils kept coming in until about July 5 and not until three weeks later or after four applications of the poison, were any squares formed. The most successful experiments with the use of dry arsenate of lead were where the stalks had been destroyed the previous fall and the number of hibernating weevils had been so reduced that but a small number escaped the poisoning.

As might be expected the experiments indicated that early varieties show more benefit and it seems probable that the poisoning will be more profitable on the limbless type of cotton than on the spreading sorts, due to the smaller area necessary to dust. Fertilizers also aid in producing earliness with a corresponding greater benefit from the dusting. The applications in the experiments were made at weekly intervals, but the experiments do not show just how often the dusting can be made to best advantage. This needs further work and other points in the practical use of the poison will need to be determined by experiment as the method of application will probably vary with the season and various conditions.

Mr. Ed Neuwirth at West Monroe, La., secured the best results of several planters who made a practical test of the dry arsenate of lead, securing 1461 pounds of seed cotton per acre where it was dusted and 827 pounds per acre on that not dusted, giving an increase of 634 pounds per acre or 76 per cent. He used 6 lbs. of poison per acre, giving four applications. The authors

recommend that the poison be applied first when the first squares appear and that five applications be given at weekly intervals. In order to kill the greatest possible number of weevils when the later applications are made, while the cotton is budding, the poison must be blown into the squares. The first application requires 2½ pounds per acre and the fifth 5 to 7 pounds per acre. The margin of profit in poisoning is determined by the market price of cotton and also by the cost of arsenate of lead and of labor. With cotton at less than 8 cents, there would be practically no profit with the present cost of labor and materials.

The authors are to be commended in very clearly pointing out that the treatment will be ineffective unless carefully done and their directions are explicitly followed. The cautions given the planter are precise and every effort is made to point out the possibilities of failure. Such an attitude on the part of those bringing out a new remedy of such great economic importance to the whole cotton belt is most commendable and is worthy of emulation.

As the origin of arsenate of lead as an insecticide was incidental to the campaign of Massachusetts against the gypsy moth, so the dry form has been evolved as a boll weevil remedy, and will quite probably come into wide use against other insects as it possesses many points of superiority to other dry arsenicals.

E. D. Sanderson

Current Notes

Conducted by the Associate Editor

Dr. C. J. S. Bethune has recently resigned as Editor of Canadian Entomologist, and has been made Editor Emeritus of that Journal. Dr. Bethune edited the first five volumes when he was succeeded by Dr. Wm. Saunders who edited the magazine for thirteen years. Dr. Bethune then again took up the work and has continued it until the beginning of the present year, thus editing twenty-eight of the forty-one volumes already issued. Dr. Bethune is succeeded as editor by Dr. E. M. Walker of the University of Toronto.

William Morton Wheeler, Ph. D., Professor of Economic Entomology in Harvard University, delivered eight illustrated lectures during January at the University of Pennsylvania on "The Development and Significance of Animal Societies."

Mr. Alfred F. Satterthwait of Middletown, Pa., has withdrawn from the position of Assistant Economic Zoölogist of Pennsylvania. Mr. Satterthwait expects to continue in entomological work and is open for an engagement.

The proposed memorial to the late Dr. James Fletcher will take the form of a drinking fountain, consisting of a granite shaft with bronze medallion inscription. It will be erected at the Central Experimental Farm at Ottawa, Canada.

The Connecticut legislature at its last session, appropriated $30,000 for a fire-proof addition to the chemical laboratory of the Agricultural Experiment Station at New Haven. The building is now being constructed and will be ready for occupancy during April. Though a small portion of the new struc-

ture will be devoted to chemistry, the entomological department of the station will have convenient quarters on the second floor, consisting of office, collection room and laboratory with dark room and small insectary connected, giving altogether about 1,400 square feet of floor space. As the corresponding space on the lower floor is to be occupied by the botanical department, all the collections of the station will hereafter be housed in a fireproof building. In the basement an exhibition room about 20 x 26 feet will be used to display pumps, insecticides and fungicides.

From the March Entomological News we learn of the death of Mr. Henry Ulke of Washington, D. C., on February 18th. Mr. Ulke was 89 years of age and was a well known Coleopterist and portrait-painter.

Professor Charles H. Fernald of the Massachusetts Agricultural College, Amherst, Mass., who has been quite ill since December, is now able to be out again.

Entomological News for March, records the death at San Francisco in February of Mr. George Willis Kirkaldy of Honolulu, H. I. Mr. Kirkaldy was a well known Hemipterist, and the first volume of his catalogue of the Hemiptera of the world has already been published. Mr. Kirkaldy was 35 years of age. He was one of the active members of our association.

Mr. F. A. Johnston, a graduate student at the Massachusetts Agricultural College, has accepted a position with the Bureau of Entomology at Washington, D. C.

Work is progressing rapidly on the new Entomological building of the Massachusetts Agricultural College, Amherst, Mass. This building is now roofed in and is expected to be finished some time next summer. It is large, commodious and fire-proof. We hope to publish a detailed description of the building in a future number of the Journal.

Mr. H. O. Marsh of the branch of Truck-Crop and Stored-Product Insect-Investigations of the Bureau of Entomology, U. S. Department of Argiculture, has resumed work at Rocky Ford, Colorado, where he had headquarters last year.

Mr. A. B. Massey, B. S., a graduate of the North Carolina A. & M. College, has been appointed laboratory assistant in Entomology at the Agricultural Experiment Station, Gainesville, Florida, and entered upon his new duties the last week in January.

Prof. E. P. Taylor has resigned his position as Entomologist of the Mountain Grove Experiment Station in Missouri, to take up the horticultural inspection work in Mesa County, Colorado; his post office address is Grand Junction. The county is paying $2,000 a year for this work.

Mr. George P. Weldon, formerly an assistant in the Maryland Agricultural College, and a graduate of the Colorado Agricultural College, is also located in Grand Junction and is acting as field Entomologist for the Agricultural Experiment Station at Fort Collins.

Mr. Donald J. Caffrey, graduate of the Massachusetts Agricultural College and a graduate student of its Entomological department, has accepted a position as assistant to the State Entomologist of Connecticut. Mr. Caffrey entered upon his duties January 17th and will have charge locally of the Gypsy Moth Suppression work at Wallingford.

Mailed April 15, 1910.

JOURNAL

OF

ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 3 JUNE, 1910 No. 3

ON THE HABIT WITH CERTAIN CHALCIDOIDEA OF FEEDING AT PUNCTURE HOLES MADE BY THE OVIPOSITOR

By L. O. HOWARD

In his article on the importation of *Tetrastichus xanthomelænæ* in the Journal of Economic Entomology, Volume I, No. 5, 1908, pages 281–289, the writer described the observations of Paul Marchal on this European Tetrastichus in which he showed that in many cases the ovipositor is used as a pin to pierce the shell of the egg in order that the adult may suck its contents. He showed that many punctures were made in this way without oviposition and apparently for the purpose of feeding. Similar observations were made by Mr. W. F. Fiske when this same parasite was imported into this country.

Again in the Journal of Economic Entomology, Volume II, No. 4, August, 1909, page 278, Dr. H. T. Fernald mentions an undetermined parasite of the eggs of the asparagus beetle (*Crioceris asparagi*) and in a circular of the Massachusetts Agricultural Experiment Station (No. 23, published July, 1909) Doctor Fernald states that one of the observers of this insect at Concord, Mass., reports seeing the parasite occasionally attack the eggs with its mouth parts, consuming the contents of the eggs. He stated that he had not observed this himself and was of the opinion that the observation needed verifying. Mr. C. W. Prescott, of Concord, Mass., on May 23rd noticed that a number of the eggs of the asparagus beetle were empty and dead. He told Mr. J. B. S. Norton, of the Bureau of Plant Industry, who was there, about it, and together Mr. Prescott and Mr. Norton examined the eggs carefully. They saw the parasite thrust

its ovipositor into the eggs, and afterwards noticed it mouthing the aperture and apparently absorbing the contents of the eggs. This observation was reported to the Bureau of Entomology, and Mr. A. F. Burgess of the Bureau visited Mr. Prescott's place and verified the observations. In several instances he noticed that the parasites licked the wounds made by the ovipositor after it was withdrawn from the egg, but in other instances direct feeding upon the eggs appeared to be evident by their gradual collapse. The parasite in question was described by Mr. J. C. Crawford in the Proceedings of the Entomological Society of Washington, Volume XI, No. 3, October, 1909, as *Tetrastichus asparagi*, from specimens received from Doctor Fernald.

In the Comptes rendus hebdomadaires des Séances de l'Académie des Sciences de Paris, vol. CXLVIII, no 18, p. 1223–25, May 3, 1909, Dr. Paul Marchal gives some interesting observations on the oviposition of Aphelinus, under the following title: "La ponte des Aphelinus et l'intérêt individuel dans les actes liés à la conservation de l'espèce." His observations were made upon *Aphelinus mytilaspidis* in relation to *Aspidiotus ostreæformis.* The observations in brief are as follows:

"Before egg-laying the Hymenopterous insect places itself about the center of the scale which covers and completely hides each of the Coccidæ. Then it advances slowly towards the periphery of the scale with a light, balancing, sidewise movement of the body and palpitating with its antennæ. Arriving at the edge it turns brusquely towards the center, and on different occasions it begins again in other radial directions the same manœuvres without leaving the Coccid. The object of these singular preliminaries seems to be to explore the Aspidiotus in order to find out whether the conditions requisite for the laying exist, and perhaps also to choose in this Aspidiotus an appropriate spot for the egg which it is to insert. In July it happened that many of the scales covered only dry Aspidiotus which had been killed by the parasites of the preceding generation, and the Aphelinus were obliged to visit many before finding one which was in good condition for laying. In general they did not remain long upon the dried Aspidiotus, and after having explored them by some movements from the center to the periphery they abandoned them.

"When on the contrary the Aphelinus found living Aspidiotus, it explored for a rather long time, according to the method just indicated, and then inserted its ovipositor so as to completely pierce the scale. The ovipositor, at first only partly inserted, finally penetrated completely, so that the belly of the parasite came in contact with the

scale of the Coccid and the ovipositor remained thus inserted for some minutes. The Hymenopter then withdrew the ovipositor and applied its head to the puncture and licked the imperceptible moisture. It then again inserted its ovipositor, and again the puncture was licked.

"I have thus seen one of them pierce the same Aspidiotus eight times and each time bend its head to the wound to lick the liquid which issued. Without interruption, it pierced and licked alternately for about forty-five minutes up to the time when I stopped it. The number of punctures given by the Aphelinus to the same Aspidiotus is very variable. Frequently it does not exceed two or three, but it can also be much greater.

"It is very certain that each thrust of the ovipositor does not correspond to the deposition of an egg, for I have only once found two eggs of the Aphelinus in one Aspidiotus upon which one of these Hymenopters had worked in its accustomed manner for an hour. In other cases it has been impossible not to discover the egg of the parasite, which is rather large and could not escape my attention. It is then very probable that the Aphelinus pierces certain Aspidiotus only for nourishment. In any case many of the stings with the ovipositor are given exclusively for this reason."

Just as Marchal's observations upon the curious feeding habit of the Tetrastichus on the elm leaf-beetle eggs were soon followed in America by observations upon a congeneric insect attacking the asparagus beetle eggs, so in the case of the Aphelinus and its Diaspine host Marchal's observations have been verified in America. At this date of writing the writer has before him a note made November 7, 1908, by Mr. J. G. Sanders, then of this Bureau. Mr. Sanders's note reads as follows:

"The oviposition of *Aphelinus fuscipennis* on *Aspidiotus rapax*.

"On opening a package of *Aspidiotus rapax* from Catalina Island, California, several parasites, *Aphelinus fuscipennis,* were noticed upon the twigs. One female was observed upon the summit of a female scale of *Aspidiotus rapax* critically examining the surface of the scale with innumerable sweeps of the antennæ from the margin to the apex of the scale. After a moment's observation the ovipositor was thrust into the scale near the apex, and constant working of the abdomen was continued for eight minutes, when the ovipositor was withdrawn and the Aphelinus turned about *and apparently sealed the wound in the scale with her mandibles.*"

An attempt has been made to watch the oviposition of other scale insect parasites in the Department greenhouses since the arrival of

Doctor Marchal's last paper, but nothing comparable to his observations has been noticed as yet. We have, however, now four independent observations upon four different species of parasites and hosts, and it seems more than probable, now that attention has been called to this matter, that this interesting and apparently (to the species concerned) important habit will be found to be quite widespread.

I close this note with a transcription of Marchal's closing paragraph in his last paper:

"Ces exemples, que les observations ultérieures ne pourront manquer de multiplier, montrent que l'intérêt individuel peut se manifester assez fréquemment par des habitudes normales dans l'accomplissement des actes qui accompagnent la ponte et qui ont pour but d'assurer la conservation de l'espèce chez les Insectes. Il y a là un facteur jusqu'ici négligé et dont il convient de tenir compte dans l'étude de l'évolution et de la spécialisation souvent si étroite des instincts liés à la reproduction qui s'observent chez les Insectes et, en particulier, chez les Hyménoptères."

LOCUST DESTRUCTION IN SOUTH AFRICA

By C. W. Howard, *Chief of Entomological Section, Department of Agriculture, Moçambique*

Probably nowhere in the world have locusts been so destructive and exercised such a baneful influence on agricultural pursuits as in South Africa, and nowhere else has so unique a method for combating them or so perfect an organization for local extermination been developed. Although reports of the work have been frequently noticed in American Entomological publications, I know from personal correspondence that very few of the American workers are thoroughly familar with this South African work. For this reason a brief resumé may be of interest. It will deal mostly with conditions in the Transvaal as it was in that Colony that the author had the privilege of conducting two large locust campaigns.

Locusts have been known in South Africa since the earliest records. Immense swarms in the earliest days of settlement are said to have swept down into Cape Colony from the North and North West, destroying everything before them.

I myself have seen swarms with a frontage of 15 or 20 miles and at least 60 or 70 miles long, taking several days to pass a given point and filling the air so thick that the glint of the sun on their wings made one easily fancy he was in a snowstorm. Traveling through such a swarm is not pleasant and many horses will not face it. More-

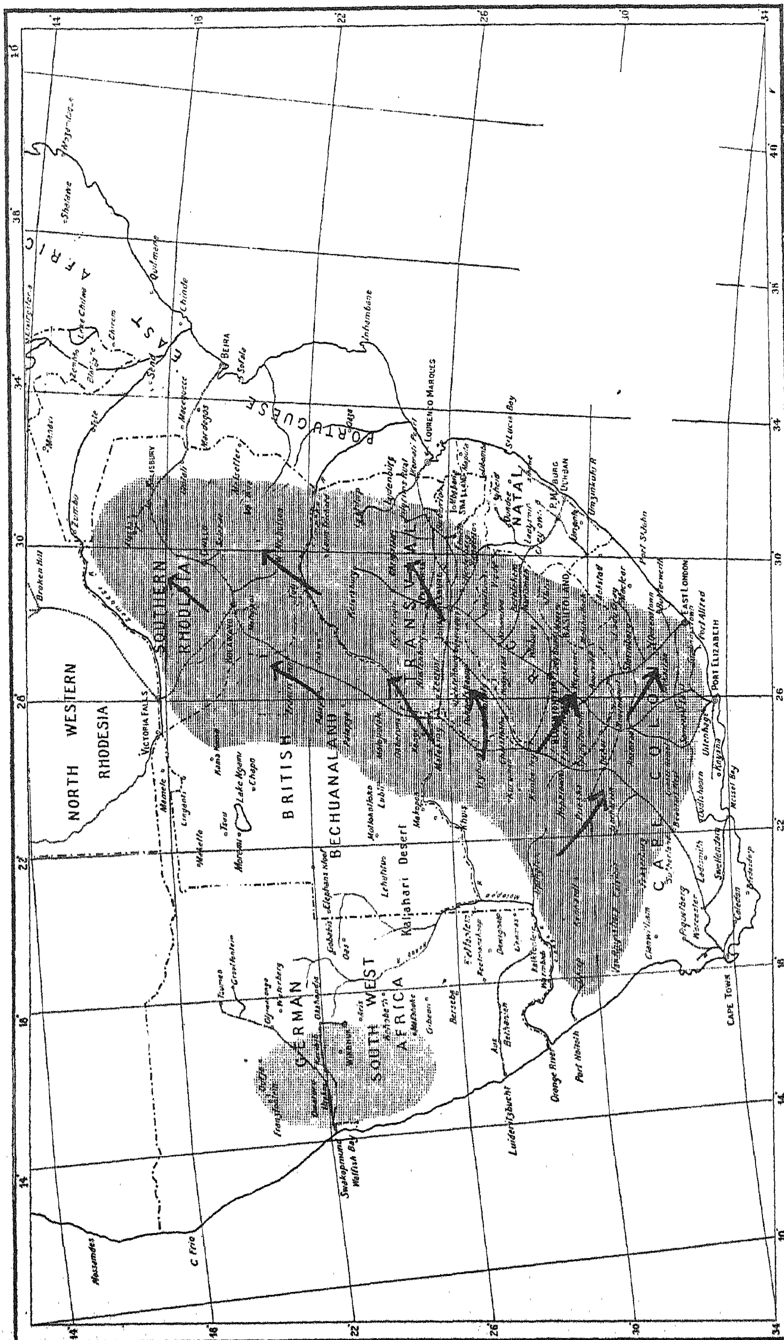
over trains were often delayed by the greasy crushed forms on the tracks. A swarm such as this will do a vast amount of damage. Scarcely a green thing is left behind, even the washing hung to dry on the line may be partly devoured and the ground is covered with a thick carpet of the fæces. Large trees are completely broken down by the weight of the sleeping locusts at night; the veldt is stripped bare of the green grass in the dry season and every winter crop of grain, etc., is cut down. When there are dozens of such swarms in a country the size of the Transvaal it can easily be imagined what the results are to the farming population. During the invasion of the winter of 1906 we endeavoured to secure statistics of the loss occasioned, and we found that at least £1,000,000 of crops, including damage to the veldt, had disappeared into the stomachs of these locusts.

The flying locusts come in the dry season when few crops are growing and those usually small in plots which can be irrigated and which can be protected, at least partially, from the ravages of the flying locusts. But with the first rains come the hoppers, the progeny of invading swarms of flyers. The hoppers have been aptly termed voetgangers, by the Dutch population, voetganger being the term for infantry. When a district is full of hoppers, not in swarms of feet or yards in extent but often actually miles in extent, marching like an army so thick as to turn the veldt brown, the farmers may well give up in despair. Nothing will turn them from their course and every green thing disappears before them.

During the season of 1906–'07, referred to above, when locusts oviposited in enormous numbers over the whole Transvaal, the statistics, also referred to above, showed that at least £10,000,000 worth of crops were preserved through the actions of the Government, which would have otherwise been destroyed and the population both black and white reduced nearly to starvation. This work of destruction was done by the Government at a cost of about £12,000, an infinitesimal sum compared with the value of the crops saved. So thoroughly was the work done that scarcely a swarm of voetgangers was able to escape destruction and reach maturity.

To correctly understand the locust problem of South Africa, however, it must be remembered that we have two species of locusts, distinct in their habits and distribution. This is a fact ignored by many European writers on the subject and has caused much confusion. Because locusts also occur in Egypt, Algeria and Central and East Africa many have tried to prove that the Sahara desert was the center from which locusts spread out North, East and South over the

Plate 17



Approximate area which may be covered by Flying Brown Locusts during the winter invasion and in any part of which they may breed

whole continent; whatever may be the facts concerning North and East African locusts those of South Africa, so far as we have been able to ascertain have no connection therewith.

I shall avoid the points still open to discussion and state briefly the main facts about the migrations and life history of these two locusts.

The most destructive and the most difficult to combat is the Brown Locust (*Pachytylus sulcicollis*). It is a small locust of quite a uniform brown or dark straw color. Its permanent summer quarter (January to March or until July) seems to be somewhere in the Kalahari desert and German South West Africa. From here they begin to spread out in March, but sometimes not until July, the winged swarms eventually covering an area which may include, Central and Eastern Cape Colony, Orange Free State, Basutoland and most of Southern Rhodesia. Apparently they seldom cross to the North of the Zambesi River, and only at the height of the cycle will they cover the entire area mentioned above. So far as we can ascertain their flight is affected very little by winds, although certain seasons, for some reason, the bulk of the swarms turn to the south east from the Kalahari and during other seasons to the north east.

By about the first of July these winged swarms begin to oviposit. Each female deposits two or three pods of eggs of about 40 eggs each, and then perishes. Males may survive one or two months longer. The eggs lie in the ground until the first rains, which usually begin about the first of October. In two weeks after the rains the first hoppers appear, providing the atmosphere has been warm enough. Many variations as to time of hatching occur, owing to variations in the time of the beginning of rains and owing to the intensity of the first rains or the lack of proper temperature. I have seen eggs hatching only in the following February and March and eggs deposited in the areas of Cape Colony where rain only occurs once in 6 or 7 years, will remain dormant several years and still hatch. I have kept eggs myself two years; they hatching at the end of that period when they were subjected to proper conditions, and I believe that the Cape Entomologist has secured hatchings after a lapse of five years.

From 6 to 8 weeks are necessary for the growth of the nymphs, at the end of which time they obtain their wings and immediately fly toward the Kalahari. From the Transvaal they follow almost a beeline to the south west and this is true of Rhodesia, while from the Orange Free State they go westward.

The voetgangers of the Brown Locust remain from the very first in very compact swarms, sleeping in masses in grass and scrub during the night and moving in massed columns during the day. Swarms

Plate 18

Approximate area which may be covered by flying RED Locusts during the spring migration. They may breed in any part of this area and winter in protected parts of the same.

hatched in close proximity gradually come together until miles of veldt will be covered with a mass of hoppers feeding and moving along as if under the command of a captain. Such swarms quite easily cross a river as large as the Vaal, by swimming and by forming a bridge of their massed bodies. This habit of massing together makes their destruction more easy.

The second locust, which has been given various names, such as Red-winged locust and Red locust (*Cyrtocanthacris septemfasciata,* long known as *Acridium purpuriferum*), is not so destructive as the Brown Locust. It does not cover so wide an area nor does it occur in such large swarms. The fact, however, that it occurs, not on the high interior plateau, but along the coast in very unhealthy and uninhabited parts and also the fact that the hoppers do not form such compact swarms as do those of the Brown locust, all tend to make the carrying out of measures directed against it more difficult.

The red locust is much larger than the brown and at the breeding season assumes a bright wine color on the hind wings, giving it its name. At the time of first reaching maturity the whole body also takes on a dark reddish brown tinge.

Two areas seem to be the centres of distribution for this locust. Small swarms may sometimes winter in almost any sheltered valley in the low veldt of South Rhodesia, Eastern Transvaal, or Moçambique. To the south, Natal and Zululand seem to be the favored area. To the northward the area about the Zambesi river especially south of that river and in the extreme Eastern part of South Rhodesia are always winter quarters for red locusts. From winter quarters in Natal and Zululand beginning in October, they spread out over Natal, Zululand, Swaziland, eastern Transvaal, and southern Moçambique, while Southward they may infest the coastal area of eastern Cape Colony. In the North they spread out from the Zambesi River over the Zambesia district to the northward of Quelimane; over the southern extremity of Nyassaland and over most of South Rhodesia. Red locusts are present in the northern parts of the Province of Moçambique, but as there are no white inhabitants there and the natives are not yet in subjection, very little information can be secured. The relation between these northern and southern centres of emigration is not yet known. Probably in a year when the locust cycle is at its height, swarms would migrate from Zululand all along the coast toward the Zambesi; and reports seem to indicate that swarms have passed over the Eastern Transvaal into Rhodesia. As I state above the Red locust is a coastal locust and is confined usually to the wet, humid and hot coastal areas and low veldt, but in years of unusual abundance swarms

may oviposit on the high and middle veldt of the Transvaal and southern Rhodesia covering the eastern two thirds of these colonies, so that we may then have a double infestation of locusts making the problem a more serious one.

By the first of December the Red Locusts begin to oviposit, each egg pod containing about 95 eggs. The females die and the males live on for some time more. They usually select very choice spots for oviposition, such as newly planted sugar plantations. On the Zambesi we have seen at least twenty tons of eggs dug from an area of not more than 100 acres. The eggs of this locust are not so dependent on rains as are those of the brown locust. Indeed they are usually deposited long after the rains have begun, unless it be a year of unusual drought, so that in two to three weeks after oviposition the young hoppers begin to hatch out. That is in the South the hoppers begin to appear about January first, while in the North they may be found by the middle of December.

In about two months the hoppers have reached maturity, and come together into more compact swarms than before. When they have assumed their wings they make for winter quarters, although, as we have pointed out, summer and winter areas and migrations are not so well marked out as is the case with the brown locust.

In the Transvaal and South Rhodesia it usually happened during bad seasons that as soon as the campaign against brown locusts had ceased another had to be begun against the red locust, so that the whole year, from the end of the dry season until the end of the wet season, was spent upon this one problem.

Before going farther it may be well to describe the method employed in South Africa in destroying locusts, as it is one peculiar to South Africa and so far as I know has not yet been employed elsewhere. Indeed some Entomologists in other continents, refuse to acknowledge its efficacy in spite of the lengthy reports annually issued by the various Agricultural Departments of South Africa.

It was early recognized that it was useless to attempt to destroy winged locusts at the migrating season, although every method which could be devised for their destruction was encouraged; even to urging the natives to use them more commonly as an article of food. The most that could be done was to call out all natives and white people on the approach of a swarm of locusts and by the use of smoke or beating of tins drive them off of a crop and compel them to settle elsewhere. This, however, is not an easy matter. A locust which has flown a number of miles is usually hungry and a little smoke or a little noise in a nice green field of maize or forage will not prevent his

breaking his fast. Consequently all the efforts at actual destruction were centered on the voetgangers. At first the various methods suggested in the locust reports of the United States of America, Egypt, Cyprus, and Argentine, were tried, from the digging of eggs to the use of rollers, trenches or screens and pits, to that of the famous locust fungus. All were found ineffective, owing to conditions existing in South Africa. The population is very sparse, labor is scarce and expensive and transportation and materials are very costly. Moreover these methods were not thorough and could not be carried out over wide areas except at great expense to the Government and the people were not yet broad minded enough to take up the work on their own initiative. The old Boer was indolent enough to accept a locust plague as a punishment for his sins and resorted to prayers and days of fasting, like our half-civilized ancestors of the middle ages, in the hopes of seeing a miracle wipe them out.

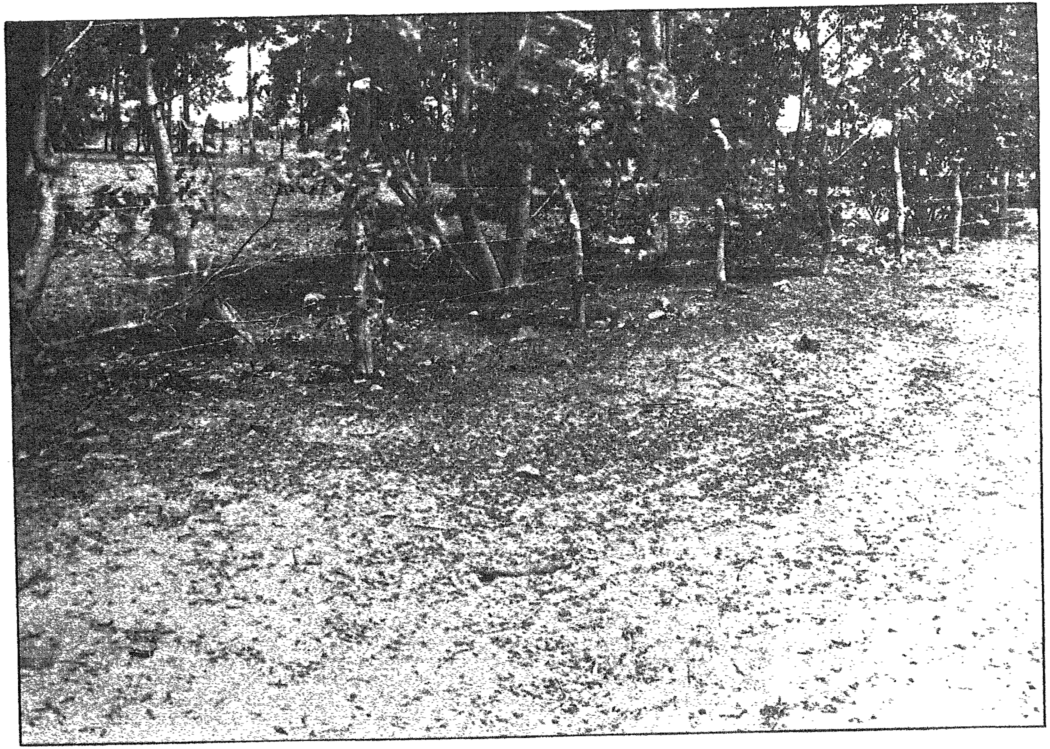
It remained for Natal to devise a method of voetganger destruction which is remarkable for its simplicity, cheapness and ease of application. The history of this discovery is interesting.

The sugar planters in Natal found the locusts very troublesome about 1894. They tried every method of destruction and amongst others the pit and screen system. The hoppers were driven into the trenches which were about two feet deep and in the bottom of which was placed four to six inches of treacle, a waste product from the sugar mills. The treacle held and smothered the hoppers. But it was soon noticed that when the trenches were filled with earth some treacle oozed out and the survivors hung about and ate the treacle and that fresh swarms seemed to be attracted to the treacle and ate it. They then tried poisoning the treacle and found arsenic the best poison. The next step was the use of a bait made of boiled sweet potatoes, molasses and arsenic, but this soon gave place to poisoned molasses sprinkled about on the grass. The credit for the discovery so far belongs to Mr. Gilbert Wilkinson a sugar planter of Natal. This method was followed for some time with considerable success. Later, I believe, at the suggestion of Mr. Lounsbury, the treacle and poison were made into a thin solution and sprayed on the grass and vegetation. This sweetened arsenical-spray is what has revolutionized the whole work of locust destruction in South Africa, because of its simplicity in mixing and applying and its complete effectiveness. The formulæ for its use vary with the size of the hoppers to be killed and the urgency of killing them. The usual strength employed is 1 lb. of arsenite of soda and 2 lbs. of crude sugar or molasses to 16 gallons of water but in special cases it may be made as strong as 1 lb.

of arsenite of soda in 8 gallons of water. Its effectiveness lies in the sugar or molasses of which locusts are very fond and to which they are attracted long distances by the odor. It is therefore best to use as crude and strong smelling a substance for sweetening as can be procured. At first white arsenic was employed, as a poison, which had to first be boiled with caustic soda to produce a soluble compound. The late Mr. Simpson improved this by introducing the use of arsenite of soda which is soluble in cold water. The latest improvement is the production of a concentrated stock solution of arsenic and sugar. Such a compound has been made, at the writer's suggestion, by the Atlas Preservative Co., of England and is known as *Atlas Locusticide.* It is put up in 1 gallon and 5 gallon tins and only needs to be mixed with the proper quantity of water before using. Locusticide has helped very much to push the work in the coastal regions such as Moçambique where transport is difficult and costly and where incompetent persons often have to prepare and handle the spray. In Cape Colony they prefer to prepare their own concentrated solution from arsenite of soda and molasses; but in other parts the cost of tins and the skilled labor necessary make such a method impossible.

The method of applying the spray is to locate a swarm of hoppers and note the direction in which they are moving. Then late in the afternoon or early in the morning spray a strip of grass varying in width from 20 feet to wider, depending on the size of the swarm, clear across the front. If it is a small swarm spray a ring completely around them. During the night the hoppers bunch up together on the grass or bush to sleep, and in the morning as soon as the sun has dried off the dew they begin to eat and move outward. Consequently if a choice bit of grass has been sprayed, this is what they will attack first. They will die in from one or two to 24 hours, depending on the strength of the solution used. So fond are they of the sugar that if not enough sprayed grass is left for all the hoppers the last comers will devour the first which have died or are dying and so one dose of poison may often kill 3 or 4 hoppers.

The writer once visited a small town in the north Transvaal which was being overwhelmed with locusts. The locust officer had just sprayed a strip of grass about 10 or 15 yards wide clear across one side of the town lands or commonage to cut off an approaching swarm of hoppers. This swarm was at least 5 miles across the front. On they came till they struck the sprayed grass where they staid awhile and fed. The spray had purposely been made weak to avoid the danger of poisoning cattle and the hoppers had taken some time to die. But when we arrived every fence corner and every corner of a house



Voetgangers killed by applications of sweetened arsenic.

and even the streets themselves were covered with dead hoppers and so overpowering was the stench that wagons had to be put on and load after load of dead hoppers was taken away to be buried.

When the late Mr. Simpson came to the Transvaal as Entomologist, it was not long before he saw that it was impossible for farming to advance until the locust problem was solved. He, therefore, began a study of the question at once. His first move was to study carefully the migrations of the swarms of flying locusts. To do this post cards were prepared. On one side was the address and franking stamp, on the other properly ruled spaces for the required information. These cards were distributed to every farmer, police, post master, railway station master, agricultural society and in fact every person who would accept them. As soon as they saw locusts they marked on the card whether they were flyers or hoppers, direction of flight or movement, egg laying, etc. As each card came in the information was recorded with pins and flags on a large map of the Transvaal and at the end of each month copied in colors on a small map. If the cards reported swarms of flying locusts which we thought would pass into other inhabited areas, telegrams of warning were at once sent out, so that farmers could be prepared to drive them from their crops. After a few months of such records had been examined, it could be easily forecasted in what parts of the Transvaal the locusts would oviposit and consequently where work of destruction would have to be carried on. This system was taken from a suggestion of Knuckel d'Hercules in his work on locusts in Algeria, and was of very great value. After two or three years of studying the migrations of locusts in this way, their movements could almost be forecasted before they approached.

The next step was to get the hoppers destroyed as soon as they appeared. At first the Transvaal farmers were afraid of the arsenic, so the Cyprus locust screens were used. After one season, however, they were abandoned as too clumsy and ineffective. In the meantime experiments and demonstrations had been carried on with the Natal spray and this method was adopted entirely. The arsenite of soda and sugar were given free to the farmers while the spray pumps (Myer's Success Bucket Pumps) were loaned free of charge. Where it was impossible to persuade a farmer to use the poison he was allowed to use a strong solution of soap and water to spray upon the hoppers. This was not very effective and took too much time to prepare, so as a rule he soon came around to the poison method.

The phenomenal success which followed the work depended, however, on the organization. The year's campaign was always preceded

by the Entomologist making a tour through the infested country, during which illustrated lectures were given, to interest the farmers in the work. Some time before the hoppers were due to hatch out, the poison and pumps had been distributed to centres convenient for distribution to farmers. Then locust officers were appointed. The Transvaal is divided into several districts over each one of which, in the affected area was placed a locust officer, directly responsible to the Entomologist as Chief Locust officer. Large districts were subdivided and officers placed over each division directly responsible to the district officers. Then under these sub-district officers were men whose duty it was to go to native locations and government lands to see that all hoppers were destroyed on them, and others to go among the farmers, giving demonstrations and persuading each man to kill the locusts on his own farm. Only men who thoroughly understood the farmers and could use tact and discretion in dealing with them were chosen as locust officers. The locust staff often included as many as 160 men. This thorough system of organization meant that every man was at his post doing his duty carefully and promptly. The Entomologist was always at headquarters and by telegraph and telephone directed the whole campaign. The work was executed quickly and with no waste of money.

It, of course, took several seasons before all the farmers fell into line, but now there is scarcely a farmer in the Transvaal who will not swear by the locust killers.

From a study of the Transvaal locust reports Mr. Simpson soon saw that the Transvaal alone could not solve the locust problem. In spite of her good work, each year new swarms invaded the colony from outside and necessitated its repetition. He accordingly placed the matter before the High Commissioner of South Africa, who called a conference in Pretoria in August, 1906, to discuss the question. This conference resulted in the establishment at Pretoria of the Central South African Locust Bureau. This was largely Mr. Simpson's idea, but almost before its organization was begun Mr. Simpson died and its management was left to his successor. The Bureau was under the direction of the Transvaal Entomologist but was supported by funds from all the Colonies and territories in South Africa including the Province of Moçambique and German South West Africa. Its work was the collection and tabulation of information regarding locusts from the whole of South Africa. The Cape Colony had already introduced a system somewhat similar to that of the Transvaal for collecting locust reports and the other colonies and territories fell into line. These reports all went to Pretoria and were there tabulated

and a monthly record map based on these reports sent to each subscribing colony. Colonies were also warned by wire of approaching swarms of flying locusts and urgency reports issued on request.

Although the work of the Bureau was supposed to be only the collection of data, it was really much broader. In May, 1907, a conference of all the Ministers of Agriculture of the various colonies was called at Pretoria by the Transvaal Minister of Agriculture in conjunction with the annual meeting of the committee of control of the Bureau. At this meeting the Bureau was able to put forward facts of such importance that each colony pledged itself to initiate locust destruction work. That was the beginning and subsequently the work has gone on well, even the native territories undertaking locust destruction. Since then the Bureau has kept up popular interest by its annual reports dealing with the work of each colony by suggesting where improvements could be made and by the issuing of information for newspapers, etc.

In dealing with the locust question we should not forget the help received from natural allies. Locust fungus was found absolutely useless, and the work of Mr. Pole-Evans, Transvaal Plant Pathologist on the fungus, has, I think, settled the question of its use in South Africa for ever. Early in the work, many birds and small mammals were found to destroy great numbers of flyers and hoppers, and a law was passed protecting several of the more important birds. These allies could, however, only be of small assistance in combating such a scourge and although they were protected very little reliance was placed on their work.

Thus during the last three years there has been active coöperation in locust destruction throughout the whole of South Africa. The results of this coöperation soon showed themselves. After the first year Brown locusts in the Orange Free State, Transvaal and Rhodesia were very materially lessened, and the next year were almost lacking in those colonies, while the past season there were none. This past year brown locusts flew down from the Kalahari and German South West Africa into Central Cape Colony and oviposited there, but that is the only part of South Africa which has been infested. The Red locusts are also disappearing. Their numbers in Natal are lessening each year, while this season there are practically none in the Eastern Transvaal and Southern Moçambique. In southern Rhodesia and northern Moçambique they are still quite numerous, but the work there is being extended each year farther into the areas of egg laying with the result that they are slowly decreasing in numbers. In the district about the lower Zambesi river two years ago immense losses

were suffered from the destruction of sugar cane and cocoanut by locusts. Last year work was begun in that area which resulted in the saving of about £250,000 worth of crops and as a further result this year locusts have invaded only a very small portion of the area.

Taking the locust problem as a whole there is, therefore, only one territory remaining over which there is not absolute control, i. e.; Parts of German South West Africa. The German Government is doing its utmost to control the pest within its boundaries but when we remember the character of the country, with its vast extent of almost desert land, with no white population and no water, we can understand the impossibility of the task. We will probably have swarms of brown locusts invading the other parts of South Africa from that region from time to time. Beyond this, however, there is no reason why South Africa should have a recurrence of such a scourge as in the past, provided she is watchful and meets each small invasion with prompt action. Now that there is to be one government over all of British South Africa, the administration of such matters as locust destruction can be from a central office where the work can be more successfully directed than heretofore.

The locust work in South Africa has had a more far reaching effect, in the Transvaal at least, than the mere saving of the crops in imminent danger. It has succeeded more thoroughly and more quickly than years of teaching and publishing of reports could have done, in converting a conservative backward people to the value of new scientific methods in combating pests of all sorts. The farmer who was formerly inclined to laugh at the Entomologist as a "bug catcher" now listens to him and accepts his advice.

NURSERY INSPECTION IN MASSACHUSETTS

By H. T. Fernald, *Amherst, Mass.*

In some respects the work of the nursery inspector in Massachusetts would seem to differ from that in most states. Of the one hundred and thirty odd nurseries requiring inspection, only two are at present growing any fruit stock, nearly all devoting themselves entirely to ornamentals. Large sales of fruit trees are made, of course, but the only evidence of this which the inspectors find during their fall inspections are small blocks of "left overs" from the spring purchases. Here, however, the San José Scale is frequently very abundant, sustaining the now well recognized fact that the inspectors in other states as well as in Massachusetts are not always infallible.

Most of the nurseries in the state are small, the average size perhaps

being ten or fifteen acres, while the largest ones are of less than two hundred acres. It is probable that almost all of the interstate shipping is done by twenty-five places, and it is remarkable how much of the stock sent out is purchased, often from the very states to which it goes.

Every nursery is actively at work shipping, by the first of October each year, and in order to complete the inspections in time to prevent holding up business, these must be begun by the tenth of July. The first places visited each year are those selling strawberries and hardy roses only, as here sales are practically continuous throughout the summer, and as by law all certificates expire July 1, these require the first attention. By the time these have been examined, work must be at once begun on the larger nurseries, which are actively shipping evergreens by the end of this month.

As to methods of inspection, there is little to be said. Fruit stock, Cornus, Viburnum, ornamental Prunus and Pyrus and other plants liable to infestation are examined individually under a lens, and with Cornus in particular, this means many weary hours during which the lowest parts of the body are the head, knees and tips of the toes. All such plants are examined separately and this is also the case with all kinds, at first. If after a prolonged search, however, no scale is found on them, the inspector considers himself at liberty to skip plants, examining every third or fourth, and finally if no evidence of trouble is found he may cross the rows in a block, examining each row as he crosses backward and forward until the block has been crossed several times at different points. From this sort of inspection nothing is considered exempt, though perhaps Berberis, Hydrangia and conifers are least thoroughly examined.

While such methods as these hold good in general, when the Gypsy moth is near the nursery, nothing can claim exemption and every plant in dangerous or even doubtful blocks is thoroughly examined. If the Gypsy moth is found, further inspection ceases until the fifteenth of September, as until that time a nursery might become infested from outside. After this date, inspection is resumed for such places and when nothing more can be found, a certificate is given, and as this expires before the next migration period for this insect, the result should mean as great freedom from it as inspection can make possible. In some cases where shipments before this date are imperative, an inspector personally goes over each plant dug, while it is at the packing shed, and if satisfactory, issues a certificate covering that shipment.

During most of the inspection period the Brown-tail moth is not

easily discovered, being either in the egg stage or in the form of very small larvæ. As it would be impossible to inspect the nurseries after the winter tents have been formed without practically preventing a large part of the business, it was decided in 1905 that inspections could not cover the Brown-tail moth, and notice to that effect was issued, while the nurserymen themselves were warned to watch for and remove any tents present on stock, unless they were prepared to lose their interstate trade.

The work as regards the Gypsy and Brown-tail moths then, is one in which this state differs from others. Other insects are watched for, of course, and occasionally found, but have thus far been of little importance as compared with those already considered. Fungus and other diseases occasionally appear, but as a rule the Gypsy moth, Brown-tail moth and San José Scale are the insects making most of the trouble.

Under the law of 1909 all nursery stock brought into Massachusetts must bear on each package, box, bundle, bale, car or other parcel, a tag issued by the Massachusetts Nursery Inspector. This has for the first time made it possible to gain some idea of the business done by other states in Massachusetts, and the result has been something of a surprise. A tag may mean a shipment of from one plant to an entire carload, but it is not likely that there are many single plants sent in this way, and as for the shipments of the fall of 1909 and spring of 1910, over thirteen thousand tags were issued, some conception of the value of Massachusetts business can be obtained.

Until the winter of 1908–09 it was impossible to get any definite information as to the amount of stock imported from abroad. During that winter, through the kind offices of Dr. L. O. Howard, some information was obtained from the Custom Houses, and during the past year it has been possible to gather data on this subject which appear to be practically complete. Thus far during the shipping season of 1909–10, three hundred and one consignments from foreign countries for points in Massachusetts have been received, most of this coming from Holland, followed by Germany, France, Belgium, England, Japan and Scotland, named in about the order of the amount of shipments. As much of this stock as possible has been inspected at its destination, but nothing has been found thus far on the European stock, except that on one lot of *Pyrus florabunda* from Holland, consisting of fifty plants, forty-five were badly injured by Crown Gall, including the worst examples ever seen by the writer. With the Japanese stock, however, it was different. A number of egg cases of the Chinese Mantis, *Tenodera sinensis* and also of another species

were present, and if these insects could survive, would be a welcome addition to the fauna of this state. Besides these, the bag of a small bag worm was found on the Umbrella Pine; a cocoon of what appears to be a Lasiocampid; an abundance of *Aulacaspis pentagona* on flowering cherry, and large numbers of *Pulvinaria camelicola* on *Euonymus alata* were found, and these on comparatively small shipments. From this, it would seem important to closely examine all stock reaching this country from the Orient. Europe has already contributed a sufficient number of insect pests, but the possibilities of the East in this regard have as yet been given little consideration, and they may prove to be serious.

THE INSECTICIDE ACT OF 1910

At the Chicago meeting of the Association of Economic Entomologists, December 27, 1907,[1] the Standing Committee on Insecticides reported as follows:

"The committee believes that it should ascertain whether it is possible to secure an interpretation of the national pure food and drug law so that it will include insecticides and fungicides, and if this is found impossible that the committee draw up and report to the next meeting of this Association a suggested law which will aid in securing uniformity of legislation in the various states as regards the compulsory analysis and labeling of insecticides and fungicides.

"Voted that the report be adopted and the committee continued."

The committee corresponded with the Bureau of Chemistry of the Department of Agriculture and found that it was impossible to so construe the Pure Food and Drug Act. The present bill was therefore drawn along the same lines as the Pure Food and Drug Act and was introduced in the Sixtieth Congress by Hon. Frank O. Lowden as H. R. 21318 and in the Senate by Senator Nelson for Senator Kittredge as H. 6515. The bill was referred to the Committee on Interstate and Foreign Commerce in the House, but it was not possible for that committee to consider it during the short session. In the Senate the bill was referred to the Committee on Agriculture and Forestry and was reported on February 1, 1909, by Mr. Burnham for the Committee. (Senate Report 895.)

It was found impossible to bring the measure to a vote in the Senate, though no opposition was encountered. The bill was again introduced in the original form in the present (Sixty-first) Congress

[1] See Journal of Economic Entomology, 1: 10.

by Hon. Frank O. Lowden of Illinois (H. R. 3658, 20989) and referred to the Committee on Interstate and Foreign Commerce.

The bill was introduced in the Senate by Senator Burton of Ohio (S. 6131). On March 8 a public hearing was given by the Committee on Interstate and Foreign Commerce of the House of Representatives to members of the Executive Committee named below assisted by Dr. J. B. Smith of New Jersey, Prof. E. L. Worsham of Georgia, Prof. T. B. Symons of Maryland, J. H. Hale of Glastonbury, Conn., and Mr. E. W. Catchpole of North Rose, N. Y., and a hearing was also given by the Senate Committee on Agriculture and Forestry. The bill was reported in the Senate on March 23 and passed the Senate April 4. The Senate bill was modified slightly to correspond with the House bill which was reported by the House Committee on April 12, passed the House in the amended form on April 18, which amendments were at once concurred in by the Senate, and the bill was approved by the President April 26. The committee highly appreciates the personal interest which both Mr. Lowden and Senator Burton evinced in securing the passage of the act and is under obligations to Chairman Mann and Senator Dolliver for the courtesy of hearings before their respective committees.

Upon the introduction of the bill in 1908, the Committee on Insecticides of the Association of Economic Entomologists consulted several of the leading manufacturers and found them favorable to such national legislation, but that they felt the entomologists, agricultural chemists and manufacturers should get together and confer over several minor changes in the bill which they desired. The committee therefore called a conference of all the manufacturers and leading entomologists and agricultural chemists, which was held at the American Institute, New York City, June 18, 1908. The meeting was a representative one of the three interests named. The bill in its original form was then taken up and carefully discussed, section by section, and amendments were made placing it in the form in which the bill was reported by the Senate Committee of the Sixtieth Congress, and the bill was finally adopted in that form. The bringing of these amendments before the proper authorities, and the proper presentation of the entire bill to those interested was left to a committee consisting of Prof. E. D. Sanderson, Entomologist N. H. Agricultural Experiment Station, Durham, N. H.; Prof. H. E. Summers, Iowa State Entomologist, Ames, Iowa; Dr. J. P. Street, Chemist Connecticut Agricultural Experiment Station, New Haven, Conn.; R. G. Harris, Sales Manager of the Vreeland Chemical Co., New York; and H. F. Baker, President of the Thomsen Chemical Co.,

Baltimore, Md., with the understanding that if any material amendments were to be made that the conference be again called together for their discussion. This committee met and organized as an "Executive Committee" and proceeded to arouse public interest in the measure and to do what was possible toward the passage of the bill before Congress.

An Advisory Board, consisting of one member from each state, was appointed to aid in securing support for the measure in each state and to these gentlemen the committee is greatly indebted for the public-spirited interest.

Certain changes in the standard of lead arsenate having been desired by certain manufacturers, a meeting of the manufacturers of arsenate of lead was called at the Belmont Hotel, New York City, December 8, 1908, and after full discussion the committee was instructed to secure an amendment to that portion of Section 7 referring to the standard for arsenate of lead so that it should read as in the bill now law.

The bill having been reintroduced in the Sixty-first Congress another conference of the manufacturers was called by the Executive Committee to ascertain if any further amendments were desired, which met at the Hotel Woodstock, New York City, November 18, 1909. At this meeting there were thirteen firms represented, which firms produce fully 80 per cent. of the insecticides of this country and the larger part of the manufactured fungicides. It was voted to recommend that the bill be amended so that the penalties prescribed in Section 2 be the same in Section 1, with this amendment the manufacturers present heartily endorsed the bill as amended and pledged their support and coöperation toward its enactment into law.

For the past two years the executive committee named above have held frequent meetings at various places and visited Washington several times in the interests of the measure and have sent copies of the bill to interested parties thruout the country thus giving the measure publicity and calling the attention of Congress to the interests of their constituents in the measure. The agricultural press has taken a lively interest in the law and has given it considerable space. The passage of the law would have been much more difficult had it not been for the liberal financial support of the leading manufacturers who contributed liberally to the expenses of the committee, the total contributions amounting to $750.00 of which $206.67 still remains in the treasury.

Altho during the Sixtieth Congress there was some slight opposition by a certain element among the insecticide manufacturers, this

disappeared during the present session and no opposition whatever developed against the bill before Congress.

It is believed that this measure will aid very greatly in the standardization of the leading insecticides and fungicides and in deterring many parties from marketing worthless or fraudulent insecticides.

It is to be earnestly hoped that any states which may pass legislation along this line will frame their laws as closely as possible in the language and with the standards of the national law as this will tend to uniformity and will greatly aid the manufacturers in labelling their goods. It would seem that with this national law there would be but little call for additional legislation in most states, but where state laws are deemed necessary there is every reason for uniformity.

E. D. Sanderson, *Chairman.*

[At the request of the chairman, the law is reproduced below.—Ed.]

SIXTY-FIRST CONGRESS

[Public—No. 152.]

[S. 6131.]

An Act For preventing the manufacture, sale, or transportation of adulterated or misbranded Paris greens, lead arsenates, and other insecticides, and also fungicides, and for regulating traffic therein, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be unlawful for any person to manufacture within any Territory or the District of Columbia any insecticide, Paris green, lead arsenate, or fungicide which is adulterated or misbranded within the meaning of this Act; and any person who shall violate any of the provisions of this section shall be guilty of a misdemeanor, and shall, upon conviction thereof, be fined not to exceed two hundred dollars for the first offense, and upon conviction for each subsequent offense be fined not to exceed three hundred dollars, or sentenced to imprisonment for not to exceed one year, or both such fine and imprisonment, in the discretion of the court.

Sec. 2. That the introduction into any State or Territory or the District of Columbia from any other State or Territory or the District of Columbia, or from any foreign country, or shipment to any foreign country, of any insecticide, or Paris green, or lead arsenate, or fungicide which is adulterated or misbranded within the meaning of this Act is hereby prohibited; and any person who shall ship or deliver for shipment from any State or Territory or the District of Columbia to any other State or Territory or the District of Columbia, or to a foreign country, or who shall receive in any State or Territory or the District of Columbia from any other State or Territory or the District of Columbia, or foreign country, and having so received, shall deliver, in original unbroken packages, for pay or otherwise, or offer to deliver, to any other person, any such article so adulterated or misbranded within the meaning of this Act, or any person who shall sell or offer for sale in the District of Columbia or any Territory of the United States any such adulterated or misbranded insecticide, or Paris green, or lead

arsenate, or fungicide, or export or offer to export the same to any foreign country, shall be guilty of a misdemeanor, and for such offense be fined not exceeding two hundred dollars for the first offense, and upon conviction for each subsequent offense not exceeding three hundred dollars, or be imprisoned not exceeding one year, or both, in the discretion of the court: *Provided*, That no article shall be deemed misbranded or adulterated within the provisions of this Act when intended for export to any foreign country and prepared or packed according to the specifications or directions of the foreign purchaser; but if said articles shall be in fact sold or offered for sale for domestic use or consumption, then this proviso shall not exempt said article from the operation of any of the other provisions of this Act.

SEC. 3. That the Secretary of the Treasury, the Secretary of Agriculture, and the Secretary of Commerce and Labor shall make uniform rules and regulations for carrying out the provisions of this Act, including the collection and examination of specimens of insecticides, Paris greens, lead arsenates, and fungicides manufactured or offered for sale in the District of Columbia or in any Territory of the United States, or which shall be offered for sale in unbroken packages in any State other than that in which they shall have been respectively manufactured or produced, or which shall be received from any foreign country or intended for shipment to any foreign country, or which may be submitted for examination by the director of the experiment station of any State, Territory, or the District of Columbia (acting under the direction of the Secretary of Agriculture), or at any domestic or foreign port through which such product is offered for interstate commerce, or for export or import between the United States and any foreign port or country.

SEC. 4. That the examination of specimens of insecticides, Paris greens, lead arsenates, and fungicides shall be made in the Department of Agriculture, by such existing bureau or bureaus as may be directed by the Secretary, for the purpose of determining from such examination whether such articles are adulterated or misbranded within the meaning of this Act; and if it shall appear from any such examination that any of such specimens are adulterated or misbranded within the meaning of this Act, the Secretary of Agriculture shall cause notice thereof to be given to the party from whom such sample was obtained. Any party so notified shall be given an opportunity to be heard, under such rules and regulations as may be prescribed as aforesaid, and if it appears that any of the provisions of this Act have been violated by such party, then the Secretary of Agriculture shall at once certify the facts to the proper United States district attorney, with a copy of the results of the analysis or the examination of such article duly authenticated by the analyst or officer making such examination, under the oath of such officer. After judgment of the court, notice shall be given by publication in such manner as may be prescribed by the rules and regulations aforesaid.

SEC. 5. That it shall be the duty of each district attorney to whom the Secretary of Agriculture shall report any violation of this Act, or to whom any director of experiment station or agent of any State, Territory, or the District of Columbia, under authority of the Secretary of Agriculture, shall present satisfactory evidences of any such violation, to cause appropriate proceedings to be commenced and prosecuted in the proper courts of the United States, without delay, for the enforcement of the penalties as in such case herein provided.

SEC. 6. That the term "insecticide" as used in this Act shall include any substance or mixture of substances intended to be used for preventing, de-

stroying, repelling, or mitigating any insects which may infest vegetation, man or other animals, or households, or be present in any environment whatsoever. The term "Paris green" as used in this Act shall include the product sold in commerce as Paris green and chemically known as the aceto-arsenite of copper. The term "lead arsenate" as used in this Act shall include the product or products sold in commerce as lead arsenate and consisting chemically of products derived from arsenic acid (H_3AsO_4) by replacing one or more hydrogen atoms by lead. That the term "fungicide" as used in this Act shall include any substance or mixture of substances intended to be used for preventing, destroying, repelling, or mitigating any and all fungi that may infest vegetation or be present in any environment whatsoever.

SEC. 7. That for the purpose of this Act an article shall be deemed to be adulterated—

In the case of Paris green: First, if it does not contain at least fifty per centum of arsenious oxide; second, if it contains arsenic in water-soluble forms equivalent to more than three and one-half per centum of arsenious oxide; third, if any substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength.

In the case of lead arsenate: First, if it contains more than fifty per centum of water; second, if it contains total arsenic equivalent to less than twelve and one-half per centum of arsenic oxid (As_2O_5); third, if it contains arsenic in water-soluble forms equivalent to more than seventy-five one-hundredths per centum of arsenic oxid (As_2O_5); fourth, if any substances have been mixed and packed with it so as to reduce, lower, or injuriously affect its quality or strength: *Provided, however*, That extra water may be added to lead arsenate (as described in this paragraph) if the resulting mixture is labeled lead arsenate and water, the percentage of extra water being plainly and correctly stated on the label.

In the case of insecticides or fungicides, other than Paris green and lead arsenate: First, if its strength or purity fall below the professed standard or quality under which it is sold; second, if any substance has been substituted wholly or in part for the article; third, if any valuable constituent of the article has been wholly or in part abstracted; fourth, if it is intended for use on vegetation and shall contain any substance or substances which, although preventing, destroying, repelling, or mitigating insects, shall be injurious to such vegetation when used.

SEC. 8. That the term "misbranded" as used herein shall apply to all insecticides, Paris greens, lead arsenates, or fungicides, or articles which enter into the composition of insecticides or fungicides, the package or label of which shall bear any statement, design, or device regarding such article or the ingredients or substances contained therein which shall be false or misleading in any particular, and to all insecticides, Paris greens, lead arsenates, or fungicides which are falsely branded as to the State, Territory, or country in which they are manufactured or produced.

That for the purpose of this Act an article shall be deemed to be misbranded—

In the case of insecticides, Paris greens, lead arsenates, and fungicides: First, if it be an imitation or offered for sale under the name of another article; second, if it be labeled or branded so as to deceive or mislead the purchaser, or if the contents of the package as originally put up shall have been removed in whole or in part and other contents shall have been placed in

such package; third, if in package form, and the contents are stated in terms of weight or measure, they are not plainly and correctly stated on the outside of the package.

In the case of insecticides (other than Paris greens and lead arsenates) and fungicides: First, if it contains arsenic in any of its combinations or in the elemental form and the total amount of arsenic present (expressed as per centum of metallic arsenic) is not stated on the label; second, if it contains arsenic in any of its combinations or in the elemental form and the amount of arsenic in water-soluble forms (expressed as per centum of metallic arsenic) is not stated on the label; third, if it consists partially or completely of an inert substance or substances which do not prevent, destroy, repel, or mitigate insects or fungi and does not have the names and percentage amounts of each and every one of such inert ingredients plainly and correctly stated on the label: *Provided, however*, That in lieu of naming and stating the percentage amount of each and every inert ingredient the producer may at his discretion state plainly upon the label the correct names and percentage amounts of each and every ingredient of the insecticide or fungicide having insecticidal or fungicidal properties, and make no mention of the inert ingredients, except in so far as to state the total percentage of inert ingredients present.

SEC. 9. That no dealer shall be prosecuted under the provisions of this Act when he can establish a guaranty signed by the wholesaler, jobber, manufacturer, or other party residing in the United States, from whom he purchased such articles, to the effect that the same is not adulterated or misbranded within the meaning of this Act, designating it. Said guaranty, to afford protection, shall contain the name and address of the party or parties making the sale of such articles to such dealer, and in such case said party or parties shall be amenable to the prosecutions, fines, and other penalties which would attach in due course to the dealer under the provisions of this Act.

SEC. 10. That any insecticide, Paris green, lead arsenate, or fungicide that is adulterated or misbranded within the meaning of this Act and is being transported from one State, Territory, or District, to another for sale, or, having been transported, remains unloaded, unsold, or in original unbroken packages, or if it be sold or offered for sale in the District of Columbia or any Territory of the United States, or if it be imported from a foreign country for sale, shall be liable to be proceeded against in any district court of the United States within the district wherein the same is found and seized for confiscation by a process of libel for condemnation.

And if such article is condemned as being adulterated or misbranded, within the meaning of this Act, the same shall be disposed of by destruction or sale as the said court may direct, and the proceeds thereof, if sold, less the legal costs and charges, shall be paid into the Treasury of the United States, but such goods shall not be sold in any jurisdiction contrary to the provisions of this Act or the laws of that jurisdiction: *Provided, however*, That upon the payment of the costs of such libel proceedings and the execution and delivery of a good and sufficient bond to the effect that such articles shall not be sold or otherwise disposed of contrary to the provisions of this Act or the laws of any State, Territory, or District, the court may by order direct that such articles be delivered to the owner thereof. The proceedings of such libel cases shall conform, as near as may be, to the proceedings in admiralty, except that either party may demand trial by jury of any issue of fact joined in any

such case, and all such proceedings shall be at the suit of and in the name of the United States.

SEC. 11. That the Secretary of the Treasury shall deliver to the Secretary of Agriculture, upon his request, from time to time, samples of insecticides, Paris greens, lead arsenates, and fungicides which are being imported into the United States or offered for import, giving notice thereof to the owner or consignee, who may appear before the Secretary of Agriculture and have the right to introduce testimony; and if it appear from the examination of such samples that any insecticide, or Paris green, or lead arsenate, or fungicide offered to be imported into the United States is adulterated or misbranded within the meaning of this Act, or is otherwise dangerous to the health of the people of the United States, or is of a kind forbidden entry into or forbidden to be sold or restricted in sale in the country in which it is made or from which it is exported, or is otherwise falsely labeled in any respect, the said article shall be refused admission, and the Secretary of the Treasury shall refuse delivery to the consignee and shall cause the destruction or any goods refused delivery which shall not be exported by the consignee within three months from the date of notice of such refusal under such regulations as the Secretary of the Treasury may prescribe: *Provided*, That the Secretary of the Treasury may deliver to the consignee such goods pending examination and decision in the matter on execution of a penal bond for the amount of the full invoice value of such goods, together with the duty thereon, and on refusal to return such goods for any cause to the custody of the Secretary of the Treasury, when demanded, for the purpose of excluding them from the country, or for any other purpose, said consignee shall forfeit the full amount of the bond: *And provided further*, That all charges for storage, cartage, and labor on goods which are refused admission or delivery shall be paid by the owner or consignee, and in default of such payment shall constitute a lien against any future importation made by such owner or consignee.

SEC. 12. That the term "Territory," as used in this Act, shall include the District of Alaska and the insular possessions of the United States. The word "person," as used in this Act, shall be construed to import both the plural and the singular, as the case demands, and shall include corporations, companies, societies, and associations. When construing and enforcing the provisions of this Act, the act, omission, or failure of any officer, agent, or other person acting for or employed by any corporation, company, society, or association, within the scope of his employment or office, shall in every case be also deemed to be the act, omission, or failure of such corporation, company, society, or association, as well as that of the other person.

SEC. 13. That this Act shall be known and referred to as "The insecticide Act of 1910."

SEC. 14. That this Act shall be in force and effect from and after the first day of January, nineteen hundred and eleven.

Approved, April 26, 1910.

NOTES ON THE PUPATION AND HIBERNATION OF TACHINID PARASITES[1]

By W. R. Thompson

The question of the pupation of Tachinid parasites is one which has been found to present itself very frequently to those engaged in the researches in progress at the Gipsy Moth Parasite Laboratory, both on account of its biological interest and its practical importance. Very closely connected with the subject of pupation and in some cases bound up with it is that of hibernation. A short résumé of our knowledge in regard to these phases of the biology of Tachinids will, it is hoped, be of interest and possibly of some service to those who have encountered the discouraging results which have been often met with here in attempts to breed various species of these parasites through to maturity.

I am indebted to Mr. W. F. Fiske for suggesting the preparation of this paper, and for permission to use the data accumulated at the laboratory, for much of which data he is personally responsible.

Pupation. The general process of pupation among the Tachinidæ is, of course, well known. With very many species it occurs as follows: When the maggot has finished feeding upon the body of its host, and has established itself in surroundings of a suitable nature, it contracts, assuming a regularly ovoid form, the larval skin becomes smooth, gradually infiltrated with a dark pigment and of a hard and resistant character. Histolysis of the larval tissues then sets in and the development of the fully formed adult parasite is accomplished with more or less rapidity. The minute details of the developmental process cannot be considered here but on the other hand there are a number of variations in the process of pupation of a more general and not less interesting character which may be discussed in some detail. The most important of these variations are those which arise from a difference in the reaction of the parasite to the inimical influences to which it is subject in the pupal stage.

There are two classes of destructive agencies to which Tachinid parasites are subject in the pupal period. These are as follows: (1) Secondary parasitism; (2) Meteorological influences. It is, of course, apparent that most, if not all, Tachinids will be subject in exactly the same degree to secondary parasitism if equally exposed to it. On the contrary, this is not by any means true of their reaction to meteorological influences so that the forms which we have studied are

[1] Occasional contributions from the Gipsy Moth Parasite Laboratory, IV.

found to group themselves into two classes according to the effect which exposure to the last-named conditions has upon them. These classes may be described as follows:

(1). Those which habitually and of necessity enter the earth to pupate. (These being the forms upon which meteorological conditions exert a great influence.)

(2). Those which do not habitually and of necessity enter the earth to pupate, or do not do so in order to avoid the influences which affect the parasites of the first class.

It must be admitted that by characterizing the two divisions in this manner the difference between them does not appear to be very strongly marked. This is due in part to a very considerable variation in the habits of the parasites of the second class and some explanation is needed to make clear the compact nature of each group.

Whether or no the pupation of the Tachinid larva in the soil is of vital importance to it seems to be determined largely by, first, the duration of the pupal period and, second, the condition of the hibernating nymph within the puparium. In respect to the first mentioned factor it may be stated that while with all of the parasites of the first class the pupal period is of long duration this is sometimes also the case with those of the second class. The second factor is the important one as we shall now try to make clear.

Pupation of Tachinids of the first class. The pupation of these forms is characterized by the rapidity of the development of the pupa up to a certain point. Histolysis of the larval tissues and the development of the nymph to the stage where the external structures, such as the eyes, antennæ, macrochætæ, legs, wings and other appendages are as perfectly developed as they are in the fly on the point of issuing from the puparium, is accomplished frequently within thirty days after the formation of the puparium, and always long before the winter sets in. Among the forms which develop in the manner described may be mentioned *Blepharipa scutellata* Rdi. (R. D.), *Crossocosmia sericariæ* Rdi., and *Parasetigena segregata* Rdi., all important parasites of the gipsy moth. In the condition described the Tachinids are peculiarly susceptible to meteorological influences, especially in so far as these induce the drying up of the nymph within the puparium. From a large number of the puparia of *Blepharipa scutellata* and *Crossocosmia sericariæ* received at the laboratory in 1908 which were forced to pupate out of earth on account of the conditions under which the parasitized pupæ of the gipsy moth were shipped from Europe and Japan, and which were kept during the winter in cold but dry conditions, an issuance of less than one per

cent was secured the following spring. That this drying out of the nymph within the puparium, resulting in its death, is in some way correlated with its rapid development to an advanced stage long before it is ready to emerge, there can be but little doubt. No reasons for this rapid development can, of course, be given, nor can we definitely state the physiological reasons for the susceptibility of the parasite in this stage to dryness although it seems probable that the greater activity of the organs of the nymph means the requirement and giving off of a great deal of moisture from its body. At all events, an examination of puparia formed under natural conditions in woodland soil, and dug up in early spring, has disclosed the fact that the nymphs are normally subject to almost semi-aquatic conditions. The spaces between the pupal exuvium and the pupa, and between the pupal exuvium and the wall of the puparium were alike filled with a clear watery liquid.

The Tachinid larvæ seem to be instinctively aware of the danger of pupation under aërial conditions. In spite of the care now taken to send parasitized material from abroad in cold storage, it not infrequently happens that numbers of the maggots of *Blepharipa scutellata* and the two other species mentioned above, emerge from the pupæ of the gipsy moth in the shipping boxes en route. The puparia which these maggots form have been observed to be very often imperfect, larviform or nearly so, and usually not giving the fly. To determine the cause of the formation of such imperfect puparia and the conditions under which the larvæ could best pupate, an experiment with fresh maggots was undertaken in 1909. A number of these which had just emerged from gipsy moth pupæ were placed upon the surface of the soil in a shaded woodland, while others were allowed to pupate under various artificial conditions. The larvæ placed upon the soil descended into it very rapidly and formed perfect puparia in a short time. Little of interest could be deduced from the observations as to the pupation of the maggots under the various artificial conditions until the results thus obtained were compared with those secured by permitting the maggots to pupate in the soil when it at once became clear that in general, pupation is much retarded, a great irregularity in the length of the prepupal period is caused and that the maggots sometimes die without pupating, when prevented from entering the earth. So well developed is the instinct of the Tachinid maggots of the first class to seek the earth and bury themselves in it, that if a number of the pupæ of the gipsy moth which contain the larvæ of Blepharipa be confined in cardboard boxes, the maggots upon emerging from the pupæ will at once burrow down to

the bottom of the box and crawling about until they strike a corner, by means of vigorous efforts with the mouth hook and muscular contractions of the powerful body, they will often manage to make a small hole through cardboard of considerable thickness and escape. Under such circumstances, a maggot is able to force itself through an opening so small that if an effort be made to remove it forcibly when it is part way out, the death of the parasite will generally result, although left to itself it can work through successfully. This propensity of the maggot to burrow downward and seek the earth has been utilized in a device, the invention of Mr. W. F. Fiske, for handling pupæ of the gipsy moth which contain the maggots of Blepharipa or Crossocosmia. These are placed upon a piece of mosquito netting stretched over a cylinder of earth into which it is desired that the maggots shall pupate, and through which they descend upon emerging from the host pupæ, falling upon the earth and at once entering it to pupate. A small cylindrical wire screen cage tightly fitting within the top of the cylinder containing the earth catches the moths and any summer-issuing parasites as they emerge. When it is certain that no more parasites will emerge the cylinder is covered up and buried in some moist cool spot after which it needs no further attention until spring.

In the experiment with the larvæ of Blepharipa cited above, it was noted that the larvæ which were placed upon earth, after descending for a few inches, turned about and proceeded to pupate with the anterior end directed upward. This position of the puparium has been observed at the laboratory in connection with other Tachinids, and also with Muscids and Sarcophagids and is very probably the usual mode of pupation among those species of Calyptrate Muscids which form their puparia in the soil. It is, of course, designed to facilitate the emergence of the fly from the earth in the spring, as the latter reaches the surface by the alternate expansion and contraction of the ptilinum, that organ being provided with many backwardly directed spines which serve to draw the fly upward through the earth.

Pupation of Tachinids of the second class. The Tachinid parasites of the second class have presented themselves much more frequently in our work than those of the first class, and they are undoubtedly of more general occurrence. They may be sub-divided as follows: (1) Those with a long pupal period; (2) Those with a short pupal period. The first group includes those forms which having but a single generation annually, hibernate in the pupal stage, but there must also be included in it those species of the second sub-division

which although they have several generations annually, hibernate in the pupal stage, which is in consequence much longer than in the summer broods. All of these Tachinids, although they resemble those of the first class in the long duration of the pupal period, differ from them in that they can pupate out of earth and withstand exposure to aërial conditions throughout the long period of hibernation, without the drying up and death of the nymph. This ability to withstand adverse meteorological conditions is accompanied by and undoubtedly correlated with a condition of the hibernating nymph very different from what we have described in regard to the species of the first class. In these species the initial development of the nymph proceeds very slowly, and by the time when low temperatures arrest the vital processes it has only developed far enough so that the general form of the pupa is apparent, none of the appendages being structurally developed. The nymphs of this sort can always be recognized by their creamy white color and differ markedly from those of the first class. Although the wall of the puparium formed by the species of this group is often much thinner than that of the puparium of Blepharipa for example, the nymph, as has been already remarked, can withstand exposure to aërial conditions and successfully complete its development. How well the nymph is protected against drying influences may be illustrated by the following example: a puparium of *Parexorista cheloniæ* Rdi., one of the Tachinids included in the first sub-division of the second class, which had pupated at the bottom of a box containing masses of brown-tail moth cocoons from a field colony, was kept in a glass vial in the laboratory during the winter. In early spring, as some of the other puparia kept under such conditions had already produced flies, while this had failed to do so, the anterior end of the puparium was removed, without breaking the pupal exuvium, to examine the condition of the nymph within. As it appeared to be in fairly good condition, it was left in the vial, and at the time when this article was written, about two months later, development had progressed to the point where the pilosity of the eyes, the antennæ and macrochætæ of the front and face were perfectly developed. There is in fact little doubt that the fly will shortly emerge in spite of the unusually adverse circumstances with which it has had to contend. The practical value of this point became apparent in the work with this species. As it is probably the most important European Tachinid parasite of the brown-tail moth, its puparia are received here in large numbers in the imported masses of brown-tail moth cocoons. The fact that the Tachinid can pupate and hibernate successfully under aërial

conditions makes it possible to avoid the tedious and expensive methods necessary with Blepharipa and Crossocosmia, to which would be added the painful and disagreeable task of a close examination of the masses of brown-tail moth cocoons in order to secure all of the puparia of this species so that they might be buried in earth and kept moist during the winter.

As to the physiological reasons for the ability of this species and those of the same habit to withstand exposure, no more can be said than that if the advanced stage of development of the hibernating nymphs of the parasites of the first class renders them susceptible to drying influences, than contrariwise, on account of the undeveloped state and slight activity of the internal organs of these forms, they do not require so much moisture nor do they give up their moisture content so readily. Although they can thus pupate and hibernate out of the soil, some of them, as we have observed in the case of *Varichæta aldrichii* Towns., habitually descend into the earth to pupate if they can easily do so. It is, of course, impossible to deny that long exposure to very dry conditions may have a detrimental effect upon certain individuals, but it seems more likely that they pupate in the soil in order to avoid the parasitic and predatory enemies to which they would be exposed for so long a time, did they remain unprotected upon the surface of the earth.

The parasites of the second sub-division pupate in various ways which seem to be determined more by the condition of the host and the individuality of the parasite than by the factors which influence the pupation of the parasites of the first class. Some of them, among which may be mentioned *Eudoromyia magnicornis* Zett., and *Zygobothria nidicola* Towns., pupate within the empty skin of the host which tightly encases the puparium. In this situation they are no doubt to a certain extent protected from secondary parasites. The wall of the puparia of these species is, so far as we have observed, quite thin and delicate, the skin of the host serving the same purpose as does the thicker wall of the puparia of the species which pupate freely. There are also other species, such as *Tricholyga grandis* Zett., *Tachina mella* W., and *Euphorocera claripennis* Macq., which pupate loosely within either the empty host skin or the pupa. These frequently occur to the number of three or four within a single host whereas *magnicornis* and *nidicola* are nearly always solitary. Moreover they do not always pupate in the manner above described but sometimes emerge from the body of the prepupal caterpillars or from the pupa, pupating either within the cocoon of the host if there is such, or leaving it and dropping to the ground. The wall of the

puparia is much thicker than in *magnicornis* and *nidicola*. If these forms pupate loosely within the skin of the caterpillar, within the empty pupa of the latter or within its cocoon, they are very liable to the attacks of secondary parasites, as the studies of the parasites of the tussock moth have demonstrated. It is almost certain to avoid these secondary parasites and such predators as ants, which often work great havoc among unprotected puparia, that they sometimes descend into the earth to pupate, as we have observed that *Tricholyga grandis* occasionally does. On the other hand we have noticed that fresh maggots of *Pales pavida* Rdi., when placed upon earth often manifest no desire to descend into it but pupate upon the surface. The short duration of the pupal period among some of these forms probably makes pupation in the soil of rather minor importance since they are only for a short time exposed to drying influences and to secondary parasitism.

Still other species such as *Frontina frenchii* Will., as a parasite of cecropia pupate well protected within the thick cocoon of the host from which they make no effort to emerge. The parasite mentioned is frequently found in the spring in very large numbers within the cocoon of cecropia, the puparia sometimes occurring to the number of forty or more. These puparia are in some cases very thin-walled and light in color. This phenomenon we have observed to vary directly as the number of puparia present, and there can be little doubt but that it is due rather to the inadequacy of the food supply, than to such an adaptation of the species to the environment as is found in the case of *magnicornis*. This is rendered the more probable since in a study of the reproductive habits of this species we have noticed that these thin-walled and light-colored puparia produce flies which are short-lived and which do not generally develop to maturity.

Hibernation. The factors which restrict hibernation among Tachinid parasites to a definite stage in the life history, or permit of a variation in this particular appear to be the habit of the host, and individuality of the parasite. As a general rule parasites with but a single generation annually hibernate in a certain stage and in a definite manner; on the other hand, those which have several generations in a season may pass the winter in various ways. Among the single-brooded species there are some with which the specific habit of the parasite is the controlling factor rather than the habit of the host. Such forms usually hibernate in the nymphal stage within the puparium. The condition of the hibernating nymph may be either undeveloped, as in *Varichæta aldrichii* and *Parexorista cheloniæ,* or advanced, as in *Blepharipa scutellata* and *Crossocosmia sericariæ.* This

phase of the question has been discussed already under "Pupation."

Another group of Tachinid parasites, which probably have but one generation annually, are those which pass the winter within the body of the living host. Of these we have observed but a few examples, but they are of exceptional interest. One of these forms is *Zygobothria nidicola* Towns., which as a parasite of the brown-tail moth, passes the winter as a first stage maggot in the hibernating larva of its host. It is evident that in this case the factor controlling the stage in which the Tachinid shall hibernate is the very small size of the over-wintering larva of the brown-tail. Were the parasite to feed only until it had reached the second stage, the death of the host would almost certainly result immediately, or it would be so weakened that it would perish during the winter, in which cases the Tachinid would also succumb. The larva therefore remains quiescent within the body of the host until the latter has fed for some time in the spring.

Another instance of hibernation within the living host has been found to occur in the case of an undetermined Tachinid parasite of *Euchaetias egle*. The development of this parasite, which we have found in very small caterpillars, is very slow, and the maggot passes the winter in the second stage within the hibernating pupa of the host, its larval life cycle occupying over eight months. In the spring it completes its larval development and emerges to pupate. It seems evident that this adjustment of the life cycle of the parasite to correspond with that of the host must be of advantage to it, otherwise it would complete its development within the host in the autumn and pass the winter in the pupal stage.

As has been indicated above, it seems probable that both of these species are single-brooded as the larval stage is of such long duration, but it is impossible to say so definitely. In the present state of our knowledge in regard to these subjects it is dangerous to draw many deductions. It will, in fact, be rather surprising if subsequent discoveries do not upset some of the generalizations which we have ventured to make.

One of the most interesting modes of hibernation which we have yet discovered has been found with some forms which pass the winter as third stage larvæ within the dry and otherwise empty skin of the host, emerging therefrom and pupating in the spring. This method of hibernation we have so far observed only with two undetermined species, one a parasite of *Datana* sp., the other infesting a European caterpillar, which is possibly *Cnethocampa processionea*. The condition of the hibernating larvæ is characteristic and worthy of remark. They are of a golden yellow color, this color being very probably due

to the fatty reserve material which they contain and the skin is of a hard firm texture. The larvæ in this respect resemble those of certain Sarcophagids which as we have observed, are able to remain alive in dry receptacles without food for several months, owing to the impermeable nature of their integument and the great amount of adipose tissue which they contain.

The hibernating habits of the Tachinids which we know to be several-brooded seem to be more variable in character within the species than is the case with the single-brooded forms. With these species there are at the beginning of the period of pupation individuals of the same species in different stages, this being a phenomenon of common occurrence among several-brooded insects in general, of which it is not necessary to explain the causes. Moreover, among a number of individuals of the same species some complete their development and emerge during the summer, while others undergo a suspension of the vital activities in the larval or pupal stage. These forms have as a rule many hosts. Among them may be mentioned *Tachina mella, Frontina aletiæ* Riley, and *Compsilura concinnata* Meig. The first two of the Tachinids mentioned have received considerable study as parasites of the tussock moth, and it was noted by Doctor Howard[1] that from a number of puparia of the second species mentioned, which were secured during the summer of 1895, the majority of the flies issued from September 19 to October 15 of the same year, but a single specimen issued April 16, 1896. Doctor Howard remarks that, "The usual method of hibernation here must be also in the imago stage although in the case of the fly which issued April 16 the puparium must have over-wintered. With these conclusions we fully agree, having observed the same phenomenon to occur in the case of *Tachina mella* and *Exorista amplexa* Coq., as parasites of the tussock moths. In Mr. Coquillet's "Revision of the Tachinidæ" a number of records are given of the issuance of *Euphorocera claripennis* from larvæ collected the preceding season, although it is not clear from the data presented whether the Tachinids passed the winter as puparia or in some of the larval stages. Similar records are given for *Winthemia quadripustulata, Sturmia inquinita* v. d. W., *Frontina frenchii,* and several other species. In the cases of this sort which have come under our notice we have found that the parasites hibernate as undeveloped nymphs within the puparia in the same manner as does *Parexorista cheloniæ.* The advantage of this mode of hibernation to the parasite is quite apparent. A number of the

[1] 1897. L. O. Howard. A Study in Insect Parasitism. Bull. No. 5, Tech. Series, Bur. of Ent. p. 43.

parasites of the tussock moth always elect to pupate within the cocoons of the host and among these there are some which do not emerge until the following year. Exposed as they are to meteorological conditions, if their nymphal development continued to the stage which it attains in *Blepharipa scutellata* before hibernation commenced, they would stand small chance of passing the winter successfully.

The most remarkable example of the entrance of certain individuals into hibernation, while others complete their development much more rapidly, has been found in the case of *Compsilura concinnata,* which is a several-brooded European parasite of the gipsy moth and other hosts. In experiments which we have conducted with this species and *Hyphantria textor* we have found that although some of the parasites finished their larval development and emerged from the host caterpillar within a short time, others attempted to hibernate as first stage larvæ within the pupa of the webworm. Less frequently, we have found *concinnata* hibernating in the same stage in the over-wintering brown-tail moth caterpillars in somewhat the same manner as does *Zygobothria nidicola.* Pantel, in his fine work, "Recherches sur les Diptères a larves entomobies," has noted what is probably the same thing with *concinnata* as a parasite of Pieris. He says: "In a lot of chrysalids of Pieris collected in autumn, of which some were unparasitized and others infested by Compsilura, there was a division; some butterflies emerged before the winter, their development following the æstival type, but the eclosion of others was retarded until spring. Now, the parasite behaves in exactly the same manner; some individuals finish their larval development in some days and emerge to pupate, while others will only emerge at the end of the winter or in spring." Although the author does not indicate precisely that the larva of *concinnata* hibernates in the first stage, there can be little doubt, from remarks which he has made previously in the same paper, that this is what occurs. Pantel attributes the singular behavior of the parasite to seasonal influences, especially those of temperature. It seems that this will scarcely explain the matter satisfactorily. To begin with, it is difficult to imagine that conditions of temperature should affect so markedly the length of the life cycle in certain individuals, without influencing that of others which are in precisely the same conditions. The question also presents itself: what would happen to the parasite should it elect to hibernate in the first larval stage in a caterpillar which invariably developed to the adult stage before the advent of winter? To avoid admitting the possibility of such an occurrence one would be forced to the conclusion that certain,

but not all of the larvæ of this species were affected in a definite manner by hosts which pass the winter in the larval or pupal stage. Such a reaction between host and parasite, if it exists, must be of a most subtle and complex character, and it would be quite useless at the present time to speculate upon its nature.

It would be interesting to know whether any of the individuals which, as Pantel states, "finish their larval development in some days and emerge to pupate," pass the winter in the nymphal stage within the puparium, which he does not clearly explain, although he remarks that the pupal period varies from 13–16 days in summer, to 30–60 in winter, which makes it seem probable that some of the parasites might in some cases hibernate as nymphs. We have never observed such an occurrence here although we have handled large numbers of the puparia, which were, however, an earlier brood than the one of which Pantel speaks.

The hibernation of *Frontina frenchii* as a parasite of cecropia has been already discussed in an earlier paper on the parasites of the Saturniidæ. It seems very likely that this parasite often hibernates in both the puparium or adult stages. As a parasite of cecropia, on the other hand, it hibernates within the living pupa of the host in large numbers, reaching the third larval stage and emerging to pupate within the cocoon of the moth in early spring. While this resembles the mode of hibernation of the Tachinid parasite of Euchætias in general it is worthy of separate mention as it offers an example of the change in the habits of a many-brooded species, whose life cycle is ordinarily quite short, whereby it adapts itself to the conditions found in a host hibernating in the pupal stage, and thus secures a more advantageous method of hibernation.

It seems likely that many species of Tachinids hibernate in the adult stage. The abundance of many forms late in the autumn, many of them females almost fully mature sexually, seems to indicate it. We have, moreover, observed such mature females of one of the European parasites studied which attempted to hibernate and this when they might have deposited their eggs had they so desired. If such a habit is at all common, it is more than likely that the fertilized females alone survive the winter. In our researches we have always found that the life of the male is shorter than that of the female and that its ability to withstand adverse conditions is not so great.

Although it is impossible to explain the variations in the hibernating habit which we have indicated, the general reason for their existence is very clear. They are evidently natural safeguards to prevent the extinction of the species in that they give it more opportunities

for passing successfully through the most critical period in its life history, the period of hibernation. That such variation has not yet been found within the species which have but one generation annually is not especially strange. With such forms the host relations and the character of the life processes are fairly definite and restricted, and all of the individuals of the species usually develop to about the same stage by the beginning of winter, whereas in the many-brooded, polyphagous species, there are often at the beginning of the season of hibernation specimens in several stages which must get through the winter as best they can. This we imagine to be the cause of the curious and varied methods of hibernation which have developed in these forms.

Conclusion. It is quite certain that only a small beginning has been made in the study of the interesting phases of the biology of Tachinid parasites which have been discussed in this short paper. It is hoped that the few data which we have thus far accumulated will be of some interest in themselves. They have in addition a certain practical value, for in the study of any injurious insect a knowledge of its parasitic enemies is desirable. In the case of Tachinids this is sometimes difficult to obtain because failure to rear the parasite to maturity renders its specific determination impossible. This difficulty has been encountered here, more especially on account of a lack of knowledge of the habits of the Tachinids which hibernate in an advanced nymphal stage, which must be provided with conditions as closely approximating the natural as can be devised. Since it is impossible to predict what the habits of a given species may be, all the forms which are met with must be allowed to pupate under the best possible conditions. The method which up to the present has given the most satisfactory results is as follows: Wire screen cylinders are constructed of brass or copper screen, having preferably not less than twenty meshes to the inch. These cylinders may be of varying sizes but it is well to make them not less than six inches in length. They are filled with soil obtained in shaded woodland, a core of earth of the same size as the cylinder being cut out and transferred with as little disarrangement as possible. We have found that with such soil better results are obtained than with loose loam because the innumerable fine rootlets in the woodland soil prevent the maggot from descending very far before pupation. In loose loam, on the other hand, it may burrow down for a considerable distance before pupation, and the settling of the soil above the puparium during the winter may make it difficult or impossible for the fly upon emerging to reach the surface. On this account, too, it is a good plan to pack

quite firmly the earth in the cylinders. They may then be fumigated with carbon bisulphide to kill any creatures which might attack the puparia of the Tachinids, and when they have been afterward thoroughly aired, the Tachinid larvæ as they emerge from their hosts, may be placed in them and allowed to pupate as they wish. This may be facilitated by placing material suspected to contain Tachinids upon a piece of mosquito netting stretched above the earth in a cylinder in the manner already described earlier in this paper. The cylinder may then be sunk in the ground in some cool, moist place, examined from time to time in the summer to secure the summer-issuing species and again the next spring for the hibernating forms. The essential thing is that the earth in which the maggots have pupated be kept moist during the winter in order to successfully rear the hibernating species. With the forms which hibernate within the body of the over-wintering host, the methods which suffice to carry the latter to maturity will suffice for the parasites. It is only necessary to recognize that such hibernating hosts may contain Tachinid parasites whose habits and identity it is well to determine.

FOOD OF THE BOBWHITE

By Margaret Morse Nice, *Clark University, Worcester, Mass.*

INTRODUCTORY

To become effective, conservation of our valuable bird life must be based on definite knowledge of the facts. To gather the facts requires patient study, and the present paper gives the results of more than two years research and presents the most complete and convincing statement that we have of the food of any bird. As these results become generally known, by sheer weight of values involved, they will put the bobwhite, properly appreciated and protected, in every farm and garden in the land.

This paper forms a part of a more complete monograph on the Biology of the Bobwhite, which aims to discuss the species in all its complex relations to the life of the continent. Two general points, however, may be anticipated.

First, former researches have demonstrated that the bobwhite feeds almost entirely on weed seeds and insects, and that it does no appreciable damage to agriculture. Some may ask for a more detailed analysis of the insect food and may question whether the bird may not take valuable insects to such an extent as to decrease somewhat

the account in its favor. To do our work we are at liberty to choose among the many forces of living nature those most effective, most easily controlled and most agreeable. On all these counts, for destruction of weed seeds and insects, the bobwhite leaves nothing to be desired. A bird that takes so many injurious insects is welcome to the beneficial ones as well. Apparently, if we could have enough bobwhites, they would leave nothing for the beneficial insects to do.

Second, the tendency at present, over a large portion of its natural range is strongly toward extinction of the bobwhite. To reverse this tendency will require careful study of the problems involved and vigorous and concerted effort. It is generally recognized that extermination of natural enemies is the beginning of game protection. For the bobwhite, cats go farther toward accounting for scarcity and extinction of the birds than sportsmen and all other natural enemies combined. Crows, rats, skunks, weasels, minks and several of the hawks and owls, especially the three first, are enemies which must be controlled, if the species is to increase anywhere, or if the birds are even to hold their own; and no one should attempt to introduce stock for the purpose of colonization until the ground has been thoroughly gone over and all vermin exterminated. Although protected by cages, cats have repeatedly broken up nests by frightening off the brooding birds at night, and in one instance a cat disturbed a pair with a brood of fifteen chicks and all but three were dead next morning, chilled in the wet grass. One such occurrence shows that the damage a cat may do is only limited by the number of birds she is able to find. She might as easily have scared up a dozen broods in a night as one, and still, with cats ranging at will everywhere, we pretend to wonder why the bobwhite is so scarce.

The paper is, further, an illustration of the possibilites of investigating the food of a species by the feeding test method. The striking feature is the quantitative results, the day's works, but qualitatively also the fact that so many species could be added to the dietary of a bird already so carefully studied by the method of crop examination suggests that the feeding test method may with profit be applied to many species of birds. The method is sure to yield in the near future much more complete results on the side of insects destroyed. In fact, many species of insects were eaten, as they were swept up in the nets, that were not definitely identified.

The present paper is printed in the hope of educating the public and of furnishing support for the strong movement already afoot for the more adequate protection of the bobwhite. It would seem that all who read it must agree with the author's conclusion:

"If we were wise enough as a people to protect and increase our weed-destroying and insectivorous birds, they should largely control these enemies of our crops. Bobwhites, if we only had enough of them, ought to save us more than half of our $17,000,000 weed damage and of our billion dollar insect tax."

C. F. HODGE.

The experiments have been carried on since September, 1907, in Worcester, Mass., with birds that had been under domestication three and four generations. The original stock came from Kansas, Alabama and South Carolina. Eighteen birds of the third generation were used, chiefly for weed tests; some were hatched under hens, some in an incubator; all were raised in brooders. A special study was made in 1908 of one bobwhite of the next generation.

WEED SEEDS

Dr. Sylvester Judd of the Bureau of Biological Survey has made a careful study of the food of the Bobwhite by analysis of stomach contents. In his bulletin "The Bobwhite and Other Quails of the United States in their Economic Relations" he says:

"The bobwhite is preëminently a seed eater, 52.83 per cent of its food for the year consisting of seeds. The bulk of these are the seeds of plants belonging to the general category of weeds. The food of no other bird with which the writer is acquainted is so varied." (6)

"The laboratory work to determine the different kinds of food and their proportions has included examination of crops and gizzards from 918 birds. This material was collected from 21 States, Canada, the District of Columbia, and Mexico, but chiefly from New York, Maryland, Virginia, Florida, Illinois, South Dakota, Nebraska, Kansas, and Texas. Stomachs were obtained each month of the year, but unfortunately few were collected in the breeding season. Laboratory work included also feeding experiments with three pairs of captive bobwhites obtained from Kansas." (7)

In my experiments the weeds or merely the seeds were put into the cages, to see whether the birds would eat them. By this means 61 weeds were added, making 129. Dr. Judd's contributions to the following list are starred.

WEED SEEDS EATEN BY BOBWHITE

*Barbed panicum......................*Panicum barbatum.*
*Barnyard grass, barn grass, cocks-
foot, water grass....................*Panicum crusgalli.*
*Bastard pennyroyal...................*Trichostema dichotomum.*

*Beggarticks, bur marigold, pitchforks, stick seed	*Bidens* sp.
*Bindweed, bear bind, English bindweed, morning glory	*Convolvulus arvensis.*
*Black bindweed	*Polygonum convolvulus.*
Black mustard, brown mustard, grocer's mustard	*Brassica nigra.*
Blue vervain, simpler's joy	*Verbena hastata.*
Blue weed	*Echium vulgare.*
Boneset, ague weed, fever weed, thoroughwort	*Eupatorium perfoliatum.*
Bouncing Bet, hedge pink, soapwort	*Saponaria officinalis.*
Bracted plaintain, western plaintain	*Plantago aristata.*
Bull thistle, bird thistle, boar thistle, pasture thistle	*Carduus lanceolatus.*
Burdock, beggar's buttons, gobo, great dock	*Artium lappa.*
Butter and eggs, toadflax, devil's flax, snapdragon	*Linaria linaria.*
*Button weed, compass weed, poor weed	*Diodia teres.*
Canada thistle, creeping thistle, cursed thistle	*Carduus arvensis.*
*Carpet weed, Indian chickweed	*Mollugo verticillata.*
*Charlock, wild mustard, yellow mustard	*Raphanus raphanistrum.*
*Chickweed, common chickweed	*Alsine media.*
Chicory, savory	*Chicorium intybus.*
*Climbing false buckwheat, bindweed	*Polygonum scandens.*
Cinquefoil	*Potentilla canadensis.*
Common darnel	*Lolium temulentum.*
*Corn cockle, bastard nigella, cockle, rose campion	*Agrostemma githago.*
*Corn gromwell, field gromwell, red root, wheat thief	*Lithospermum arvense.*
*Crab grass, finger grass, Polish millet	*Panicum sanguinale.*
*Creeping bush clover	*Lespedeza repens.*
*Croton	*Croton* sp.
*Crownbeard	*Verbesina* sp.
*Curled dock, sour dock, yellow dock	*Rumex crispus.*
Dandelion	*Taraxicum taraxicum.*
Darnel	*Festuca elatior pratensis.*
Dodder	*Cuscuta gronovii.*
Evening primrose	*Œnothera biennis.*
*Everlasting	*Antennaria* sp.
False flax, gold of pleasure, Siberian oilseed, wild flax	*Camelina sativa.*
False nettle	*Bochmeria cylindrica.*
Fireweed	*Erechtites hieracifolia.*
*Flowering spurge, showy spurge	*Euphorbia corollata.*
Fringed black bindweed	*Polygonum cilinode.*

*Giant ragweed, hogweed, horseweed, tall ragweed ....*Ambrosia trifida.*
*Green foxtail, green pigeon grass, bottle grass........................*Chætochlia viridis.*
*Gromwell ....*Lithospermum officinale.*
*Hairy bush clover....................*Lespedeza hirta.*
Hedge mustard ....*Sisymbrium officinale.*
*Hoary puccoon ....*Lithospermum canescens.*
*Hoary vervain ....*Verbena stricta.*
Horse nettle, bull nettle, radicle, sand briar ....*Solanum carolinense.*
Horseweed, butterweed, colt's tail, fleabane ....*Erigeron canadense.*
Ironweed ....*Vernonia novcboracensis.*
*Japan Clover ....*Lespedeza striata.*
*Jewel weed, touch-me-not............*Impatiens* sp.
Joe-Pye weed, trumpet weed..........*Eupatorium purpureum.*
*Knotweed, doorweed, goose grass......*Polygonum aviculare.*
*Lamb's-quarters, goosefoot, pigweed..*Chenopodium album.*
*Lupine ....*Lupinus* sp.
*Marsh elder, false ragweed, false sunflower, high-water shrub...........*Iva xanthifolia.*
Mayweed, dog fennel, stinking chamomile ....*Anthemis cotula.*
Meadowsweet ....*Spiræa salcifolia.*
*Milk purslane, spotted spurge.........*Euphorbia maculata.*
Milkweed, silkweed, wild cotton.......*Asclepias syriaca.*
*Morning glory ....*Ipomœa* sp.
Motherwort ....*Leonurus cardiaca.*
Mouse-ear chickweed.................*Cerastium vulgatum.*
Mullein, Aaron's rod, flannel plant, velvet dock........................*Verbascum thapsus.*
*Nightshade, deadly or black-berried nightshade ....*Solanum nigrum.*
Nonesuch, black medick, medicago.....*Medicago lupulina.*
*Nut grass, coco, coco sedge, nutsedge...*Cyperus rotundus.*
*Old witch grass ....*Panicum capillare.*
*Orange hawkweed, devil's paint brush, golden hawkweed ....*Hieracium aurantiacum.*
Ox-eye daisy, bull's-eye, white daisy, white weed ....*Chrysanthemum leucanthemum.*
*Partridge pea ....*Chæmocrista fascicularis.*
*Pennsylvania persicaria...............*Persicaria pennsylvanica.*
Pepper grass ....*Lepidium virginicum.*
*Persicaria, pale.......................*Persicaria lopathifolia.*
*Pigeon grass, pussy grass, summer or yellow foxtail ....*Chætochloa glauca.*
*Pigweed, redroot, rough amaranth....*Amaranthus retroflexus.*
Plantain, white man's foot............*Plantago major.*
*Poison ivy, poison vine...............*Rhus radicans.*
Pokeweed, garget, pigeon berry, skoke..*Phytolacca decandra.*

Prickly lettuce, strong-scented lettuce..*Lactuca virosa.*
Purslane, garden purslane, pursley, pusley ....*Portulaca oleracea.*
Rabbit's-foot clover, stone clover......*Trifolium arvense.*
*Ragweed, bitterweed, hogweed, Roman wormwood, richweed ....*Ambrosia artemisiæfolia.*
*Ribgrass, black plantain, buck horn, deer tongue..........*Plantago lanceolata.*
Rough avens..........*Geum virginianum.*
Round-headed bush clover..........*Lespedeza capitata.*
Round-leafed mallow, cheeses, mallard ....*Malva rotundifolia.*
Russian pigweed..........*Axyris amarantoides.*
*Sedge ....*Carex* sp.
*Sensitive pea..........*Chæmocrista nictitans.*
*Sheathed rush grass..........*Sporobolus vaginæflorus.*
Shepherd's purse, mother's heart, pickpurse, toothwort..........*Bursa bursa-pastoris.*
*Sida ....*Sida spinosa.*
*Skunk cabbage..........*Spathyema fœtida.*
Skunk tail grass..........*Hordeum jubatum.*
*Slender finger grass..........*Syntherisma filiformis.*
*Slender paspalum..........*Paspalum setaceum.*
*Slender spike grass..........*Uniola laxa.*
*Smartweed ....*Polygonum hydropiper.*
*Sorrel: field, horse, red or sheep sorrel; sour weed ....*Rumex acetosella.*
*Spreading panicum..........*Panicum proliferum.*
Spurry ....*Spergola arvensis.*
Steeplebush ....*Spiræa tomentosa.*
Sticktight, beggar's lice..........*Lappula virginiana.*
Stinkweed, penny-cress, French weed..*Thlaspi arvense.*
St. John's wort..........*Hyperium perforatum.*
*Sunflower ....*Helianthus annuus.*
Sweet grass..........*Hierochloë borealis.*
*Switch grass, tall smooth panicum.....*Panicum virgatum.*
Tearthumb ....*Polygonum sagittatum.*
*Texas croton..........*Croton texensis.*
*Three-seeded mercury, copper-leaf.....*Acalypha glacilens.*
*Tick-trefoil ....*Meibomia grandiflora.*
*Tick-trefoil ....*Meibomia nudiflora.*
*Trefoil ....*Lotus* sp.
*Tussock sedge..........*Carex stricta.*
*Vetch ....*Vicia* sp.
Water hoarhound..........*Lycopus americanus.*
Water smartweed..........*Polygonum acre.*
White vervain, nettle-leaved vervain...*Verbena stricta.*
Wild carrot, bird's nest, lace weed, Queen Anne's lace..........*Daucus carota.*
Wild oats..........*Avena fatua.*
Wild rice ....*Zizania aquatica.*

Witch grass..........................*Agropyron repens.*
Yarrow, milfoil......................*Achillea millefolium.*
Yellow daisy, brown-eyed Susan, cone
flower ....*Rudbeckia hirta.*
*Yellow sorrel.......................*Oxalis stricta.*

Feeding Habits

Another experiment was an attempt to bring up a bobwhite in an entirely natural way so far as weeds were concerned. When he was a month old, he was taken into the garden or fields every few days, and watched to see what he would eat. He was given no weed seeds until after he had found and eaten them out-of-doors. He would experiment on many things that were not eatable, and if he had been out for half a day instead of less than an hour at a time, and if he had been taken to more places to find weeds, undoubtedly he would have eaten a greater variety.

The following seeds were his special favorites:

Barnyard grass.
Chickweed.
Pigeon grass.
Ragweed.
Yellow sorrel.

He was also fond of

Cinquefoil.
Lamb's quarters.
Peppergrass.
Pigweed.
Plantain.
Rabbit's foot clover.
Red sorrel.

In regard to the number of seeds of certain weeds that a bobwhite will eat at a meal, Dr. Judd has several records of the amounts found in single crops. In a few cases I watched a bird eat all that he wanted counting while he ate.

Chickweed	2,025	2,250	Russian pigweed	350
*Crab grass	1,000		*Smartweed	300
*Lamb's quarters		10,000	*Sorrel	550
*Pigeon grass		5,000	Stinkweed	105
*Pigweed		400	Sweet grass	200
*Ragweed		1,000		

In order to find out how many seeds of one kind a bobwhite would eat in a day the following tests were made. A weighed amount of

clean weed seeds was put into a box, which was set inside a larger box, so that any seed scratched out would be caught and all that the birds did not eat, weighed. One gram of each kind of seed was counted. Two birds were used in each feeding test; they had nothing but green food to eat besides the weed seeds.

NUMBER OF SEEDS EATEN BY A BOBWHITE IN A DAY

Barnyard grass	2,500	Milkweed	770
Beggar ticks	1,400	Peppergrass	2,400
Black mustard	2,500	Pigweed	12,000
Burdock	600	Plantain	12,500
Crab grass	2,000	Rabbit's foot clover	30,000
Curled dock	4,175	Round headed bush clover	1,800
Dodder	1,560	Smartweed	2,250
Evening primrose	10,000	White vervain	18,750
Lamb's quarters	15,000	Water smartweed	2,000

To quote again from Dr. Judd:

"A careful computation of the total amount of weed seed the bobwhite is capable of destroying is surprising in the magnitude of its result. In the State of Virginia it is safe to assume that from September 1 to April 30, the season when the largest proportion of weed seed is consumed by birds, there are four bobwhites to the square mile, or 169,800 in the entire State. The crop of each of these birds will hold half an ounce of seed, and as at each of the two daily meals weed seed constitutes at least half the contents of the crop, or a quarter of an ounce, a half ounce daily is certainly consumed by each bird. On this very conservative basis the total consumption of weed seed by bobwhites from September 1 to April 30 in Virginia amounts to 573 tons." (8)

The following tests were made in order to ascertain how much bobwhites eat each day.

Four birds ate	60	grams of weed seeds in one day.	Indoors, in November.
Two birds ate	30	" " " " " " "	" " "
One bird ate	16.5	grams of weed seeds and grain.	Indoors, in December.
One bird ate	17	" " " " " "	" " October.
One bird ate	14	" " " " " "	" " "
One bird ate	20	" " " " " "	" " "
One bird ate	15	" " " " " "	" " "
One bird ate	14	" " " " " "	" " "
One bird ate	21	" " " " " "	" " "
One bird ate	17	" " " " " "	" " "
One bird ate	14	" " " " " "	" " "
One bird ate	12	" " " " " "	" " "
One bird ate	17	" " " " " "	" " "

One bird ate 17 grams of weed seeds and grain. Indoors, in October.
One bird ate 12 " " " " " " " " "
One bird ate 13 " " " " " " " " "
Twelve birds ate 180 grams of grain in one day. Outdoors, in February.
Twelve birds ate 180 grams of weed seeds in one day. Outdoors, in February.
Twelve birds ate 180 grams of grain in one day. Outdoors, in February.

The average of these tests is 15 grams, a little more than half an ounce.

Insects

"The bobwhite eats insects in every month of the year. Moreover the large proportion of injurious insects habitually eaten renders the services of this bird more valuable than those of many birds whose percentage of insect food, though greater, includes a smaller proportion of injurious species. Conspicuous among the pests destroyed are the Colorado potato beetle, twelve-spotted cucumber beetle, bean leaf-beetle, squash ladybird, wireworms and their beetles, and May beetles. Its food also includes such weevils as corn billbugs, imbricated snout beetle, clover leaf weevil, cotton boll weevil; also the striped garden caterpillar, army worm, cotton bollworm, and various species of cutworms; also the corn-louse ants, red-legged grasshopper, Rocky Mountain locust, and chinch bug." (9)

The most important insects added by my experiments are the squash bug, plant lice, the cabbage butterfly, cankerworms, codling moth, the Hessian fly, the mosquito, stable fly, and the typhoid fly.

LIST OF INSECTS EATEN BY THE BOBWHITE.

Thysanura
  Silver fish.......................... *Lepisma saccharina.*
Ephemerida
  *May flies........................
Orthoptera
  *Cricket .... *Gryllus* sp.
  *Meadow grasshoppers.............. *Xiphidium.*
  *Meadow grasshoppers.............. *Orchelimum.*
  *Meadow grasshoppers.............. *Scudderia.*
  *Katydid .... *Microcentrum* sp.
  *Walking sticks..................... *Phasmidæ.*
  *Grouse locust...................... *Tettix* sp.
  *Rocky Mountain locust............. *Melanoplus spretus.*
  *Red-legged grasshopper............ *Melanoplus femur-rubrum.*
  *Grasshopper .... *Melanoplus bivittatus.*
  *Grasshopper .... *Melanoplus scudderi.*
  *Grasshopper .... *Melanoplus atlanis.*
  *Bird grasshopper................... *Schistocerca americana.*
Hemiptera
  Heteroptera
    *Chinch bug....................... *Blissus leucopterus.*
    *False chinch bug................. *Nysius angustatus.*

*Three-spotted soldier bug.........*Euschistus tristigmus.*
*Stink bug........................*Euschistus variolarius.*
*Stink bug........................*Euschistus* sp.
*Bug ....*Podisus* sp.
*Bug ....*Brochymena* sp.
*Bug ....*Nezara hilaris.*
*Bug ....*Mormidea lugens.*
*Bug ....*Hymenarcis nervosa.*
*Bug ....*Hymenarcis æqualis.*
*Bug ....*Thyanta custator.*
*Bug ....*Œbalus pugnax.*
*Bug ....*Trichopepla semivittata.*
*Bug ....*Cœnus delius.*
*Bug ....*Peribalus limbolarius.*
*Tarnished plant bug.............*Lygus pratensis.*
*Bug ....*Corimelæna* sp.
*Bug ....*Apiomerus crassipes.*
*Bug ....*Alydus eurinus.*
*Bug ....*Corizus* sp.
*Bug ....*Euthocta galeator.*
*Shield-backed bugs...............*Scutelleridæ.*
Squash bug.......................*Anasa tristis.*

Homoptera

*Leaf hopper.....................*Oncometopia lateralis.*
*Leaf hopper.....................*Oncometopia* sp.
*Leaf hopper.....................*Deltocephalus* sp.
*Leaf hopper.....................*Diedrocephala* sp.
Plant lice........................*Aphididæ.*
Tree hoppers.....................*Membracidæ.*

Lepidoptera

*Army worm.......................*Heliophila unipuncta.*
*Cutworm ....*Agrotis* sp.
*Cutworm ....*Feltia annexa.*
*Noctuid moth....................*Noctuidæ.*
*Cotton worm.....................*Alabama argillacea.*
*Cotton bollworm.................*Heliothis obsoleta.*
*Striped garden caterpillar..........*Mamestra legitima.*
*Yellow bear caterpillar.............*Diacrisia virginica.*
*Pyralid ....*Tholeria reversalis.*
*Purslane sphinx..................*Deilephila gallii.*
*Southern tobacco worm............*Phlegethontius sexta.*
*Caterpillar ....*Junonia cœnia.*
*Pupa ....*Vanessa* sp.
Cabbage butterfly ....*Pieris rapæ.*
Canker worms.....................*Anisopteryx.*
Tent caterpillar....................*Clisiocampa americana.*
Bee moth ....*Galleria melonella.*
Codling moth.....................*Carpocapsa pomonella.*
Clothes moth.....................*Tinea pellionella.*

Diptera

*Crane fly ....*Tipulidæ.*

*Green fly .... *Lucilia cæsar.*
*Robber fly .... *Asilidæ.*
Mosquito .... *Culex.*
Mosquito .... *Anopheles.*
Hessian fly .... *Mayetiola destructor.*
Typhoid fly .... *Musca domestica.*
Stable fly .... *Stomoxys calcitrans.*

Coleoptera

Carabidæ

*Ground beetle .... *Scarites subterraneus.*
*Ground beetle .... *Amara* sp.
*Ground beetle .... *Casnonia pennsylvanica.*
*Ground beetle .... *Platynus extensicollis.*
*Ground beetle .... *Agonoderus pallipes.*
*Ground beetle .... *Harpalus pennsylvanicus.*
*Ground beetle .... *Harpalus caliginosus.*
*Ground beetle .... *Anisodactylus rusticus.*
*Ground beetle .... *Anisodactylus baltimorensis.*

Chrysomelidæ

*Leaf beetle .... *Cryptocephalus venustus.*
*Leaf beetle .... *Colapsis brunnea.*
*Leaf beetle .... *Nodonota tristis.*
*Leaf beetle .... *Chrysomela pulchra.*
*Leaf beetle .... *Chrysomela suturalis.*
*Leaf beetle .... *Œdionychis fimbriata.*
*Leaf beetle .... *Disonycha 5-vittata.*
*Leaf beetle .... *Disonycha xanthomelæna.*
*Leaf beetle .... *Disonycha crenicollis.*
*Leaf beetle .... *Psylliodes punctulata.*
*Leaf beetle .... *Microrhopala vittata.*
*Three-lined potato beetle .... *Lema trilineata.*
*Colorado potato beetle .... *Leptinotarsa decemlineata.*
*Bean leaf beetle .... *Cerotoma trifurcata.*
*Striped cucumber beetle .... *Diabrotica vittata.*
*Twelve-spotted cucumber beetle .... *Diabrotica 12-punctata.*
*Locust leaf-mining beetle .... *Odontota dorsalis.*
*Golden tortoise beetle .... *Coptocycla bicolor.*
Elm-leaf beetle .... *Galerucella luteola.*

Scarabæidæ

*May beetle .... *Lachnosterna tristis.*
*Dung beetle .... *Onthophagus pennsylvanicus.*
*Dung beetle .... *Aphodius inquinatus.*
*Leaf-chafer .... *Diplotaxis* sp.
*May beetles .... *Serica* sp.
*May beetles .... *Anomala* sp.
*May beetles .... *Aphonus* sp.

Rhynchophora

*Imbricated snout beetle .... *Epicærus imbricatus.*
*Fuller's rose beetle .... *Aramigus fulleri.*
*Clover weevil .... *Sitones hispidulus.*
*Clover-leaf weevil .... *Phytonomus punctatus.*
*Mexican cotton boll weevil .... *Anthonomus grandis.*

*Billbug .... *Sphenophorus parvulus.*
*Corn billbug....................... *Sphenophorus zeæ.*
*Weevil .... *Thecesternus humeralis.*
*Weevil .... *Tanymecus confertus.*
*Weevil .... *Chalcodermus collaris.*
*Weevil .... *Centrinus.* sp.
Elateridæ
*Click beetle....................... *Drasterius elegans.*
*Click beetle....................... *Agriotes* sp.
*Click beetle....................... *Melanotus communis.*
*Click beetle....................... *Corymbites* sp.
Coccinellidæ
*Lady beetle .... *Hippodamia parenthesis.*
*Squash ladybird.................... *Epilachna borealis.*
*Lady beetle .... *Coccinella sanguinea.*
*Lady beetle .... *Adalia bipunctata.*
Histeridæ
*Histerid beetles...................
Tenebrionidæ
*Darkling beetle.................... *Blaptinus.*
Mealworms .... *Tenebrio* sp.
Staphylinidæ
*Rove beetles.......................
Lampyridæ
*Soldier beetle..................... *Chauliognathus pennsylvanicus.*
Cerambycidæ
*Longicorn beetle................... *Tetraopes tetraophthalmus.*
Dermestidæ
Carpet beetle....................... *Anthrenus scrophulariæ.*
Hymenoptera
*Ants .... *Lasius* sp.
*Ants .... *Tetramorium cæspitum.*
*Ants .... *Camponotus pennsylvanicus.*
*Gall flies.......................... *Cynipidæ.*
*Parasitic wasps.................... *Tiphia inornata.*
*Parasitic wasp..................... *Proctotrypes rufipes.*
Rose slug........................... *Monostegia rosæ.*
Currant worm........................ *Pteronus ribesii.*
Other animal food
*Spiders ....
*Harvest spiders.................... *Phalangidæ.*
*Thousand leg....................... *Julus* sp.
Sow bug............................. *Oniscidæ.*
*Snail .... *Pupa armifera.*
*Pond snail......................... *Succinea avara.*
*Crayfish .... *Cambarus.*
*Toad ....

The following are a few records of the numbers of insects eaten by bobwhites at single meals.

*Grasshoppers: from 20 to 39.

*Chinch bugs: 100, in another case two tablespoonfuls in a cup.

Squash bugs: 6, 11, 12.

Aphids: 2,326 eaten by a week old chick; this was more than one meal, but was not all his insect food for that day.

*Army worm: 12.

*Cutworm: 12.

Hessian fly flaxseeds: 20.

Mosquitoes: 144 — a week old bird; 568 — a nearly grown bird in three hours. In both these cases the supply gave out, while the birds were still eager for more.

*Potato beetles: 75, 101.

May beetle grubs: 7, 8.

*Cotton boll weevil: 47.

Sow bugs: 6.

Miscellaneous insects: 1,400 in half a day — a laying hen the 23rd of June.

Tests to ascertain how many insects of one kind a bobwhite might eat in an entire day gave the following results. The birds had plenty of weed seeds, grain and green food, except in two cases in which the fact is indicated.

5,000 aphids — chrysanthemum black fly. Adult bird in December. This is the only case in which the insects were not individually counted; one thousand were counted and the rest estimated.

1,350 flies. A laying hen in July. About one fifth were maggots, the rest adults.

59 adult potato beetles. A laying hen; test by Mazie Hodge.

1,286 rose slugs. A laying hen; test by Mazie Hodge.

37 grasshoppers and 2,400 seeds of pigeon grass eaten apiece by two six weeks old birds in October.

43 grasshoppers and 2,100 seeds of pigeon grass eaten apiece by two six weeks old birds in October.

20 grasshoppers and 3,000 seeds of pigeon grass eaten apiece by two six weeks old birds in October.

65 large crickets eaten apiece by two seven weeks old birds in October. They had no weed seeds or grain.

84 large and middle-sized grasshoppers eaten apiece by two seven weeks old birds in October. They had no weed seeds or grain.

700 insects — 300 of them grasshoppers. A laying hen in July. Their weight was 24 grams.

1,532 insects — 1,000 of them grasshoppers. A laying hen in July. Their weight was 24.6 grams.

Eight tests were made with an adult cock in October and November.

28 grasshoppers = 11g.	14g. of grain.	Total — 25g.
33 grasshoppers = 15g.	13g. of grain.	Total — 28g.
48 grasshoppers = 19g.	10g. of grain.	Total — 29g.
22 grasshoppers = 12g.	16g. of grain.	Total — 28g.
25 grasshoppers = 12g.	11g. of grain.	Total — 23g.
23 grasshoppers = 12g.	8g. of grain.	Total — 20g.
20 grasshoppers = 9g.	12g. of grain.	Total — 21g.
25 grasshoppers = 11g.	10g. of grain.	Total — 21g.

The average is:

28 grasshoppers = 12.5g. 12g. of grain. Total — 24.5g.

STUDY OF THE GROWTH AND FEEDING OF ONE BOBWHITE

At hatching weighed 6 g.					
5 days	8				
7	....		Ate 2326 aphids and 20 mealworms.		
8	10.5		Ate 7 grams of insects.		
9	12.5 g.	Increase 2.5			
10	13.	.5			
11	13.3	.3	Ate 330 insects.		
12	14.	.7			
13	15.	1.	Ate 514 insects.		
14	15.5	.5	225 insects	= 8 g.	Ate 51% of his weight.
*15	15.	—.5	236	7	47%
*16	14.8	—.2	400	8	54%
*17	15.8	1.	200	8	50%
18	16.5	.7	351	8	48%
19	17.5	1.	411	6.6	38%
20	20.	2.5	354	10.1	50%
21	21.2	1.2	732	10	47%
22	22.5	1.3	287	10.4	46%
23	25.3	2.8	296	11	43%
24	26.2	.9	185	8	30%
25	28.5	2.3	250	12	42%
26	30.5	2.	393	9.3	30%
27	32.6	2.1	529	10.2	31%
28	34.2	1.6	710	13.5	42%
35	43.5				
36	46.5	3.			
37	49.5	3.	102	11. + 15 g. of grain = 26	= 52%
38	51.	1.5	112	11. + 12 g. of grain = 23	= 45%
39	53.	2.	134	12.5 + 12 g. of grain = 24.5	= 45%
44	67.	....	....		
49	77.	....	....		
54	91.	....	....		
55	92.	....	....		
At 10 weeks	123.	....	....		
11	139.	16.	....		
12	153.	14.	....		
13	156.	3.	...		
14	164.	8.	....		
15	166.	2.	....		

* The loss in weight is due to his having lice for three days.

At hatching he weighed 6 g.; in 9 days he had doubled in weight. In the next 2 weeks he had doubled again, and again at the end of another fortnight. It took him 3 more weeks then to weigh 96 g.; in the

last 8 weeks of his growth he gained 75 g. For the first 12 weeks his average gain per day was 1.75 g. The average daily gain each week was as follows: .5 g., .7 g., .8 g., 2.1 g., 1.6 g., 2.35 g., 2.4 g., 2.1 g., 2.1 g., 2.3 g., 2.3 g., 2 g. The next four weeks his growth was slow; the average daily gain each week was: .43 g., 1.1 g., .3 g., .7 g.

At 4 months he weighed 170 g. which is an average adult weight for him, although sometimes he has weighed from 12 to 19 grams more.

In every case he was weighed before he had had anything to eat. He always had all he would eat in the tests, but doubtless would have eaten somewhat more in a wild state, for he would have exercised more than he did when kept in confinement. I regret that I did not make feeding tests in the first two weeks of his life, but I do not think he ever ate more than two-thirds of his weight at the most. For the first two or three days the chicks eat little, as the unabsorbed yolk nourishes them. Charles W. Nash in "The Birds of Toronto" says:

"For the first two or three months of their lives young quail feed almost exclusively on insects, and each one will, while he is growing, consume nearly its own weight of them every day." (11)

Edward Harris states in "The Quail the Best Insect and Weed Exterminator Must be Better Protected" that:

"A young quail will consume its own weight in insects every day." (4)

My results do not agree with this. A bobwhite does not have to eat so much nor grow so fast as those birds that are helpless until they nearly reach adult size.

As a result of these tests I have made an estimate of the amount eaten by a bobwhite in a year.

First 2 weeks, 72 g.=10,245 insects. The 8th day he ate 7 g. Counting nothing for two days, we might assume he ate as follows: 4, 4, 4, 5, 6, 7, 7, 7, 7, 7, 7, 7,=72. In four of these days he ate 3,415 insects. At the same rate in twelve he would have eaten 10,245.

3rd and 4th weeks, 132 g.=5,334 insects. Actual tests.

5th week, 88g.=3,520 insects. His average weight for this week was 38.8. A third of that multiplied by 7 should give an estimate of the amount eaten. With 40 insects to the gram, as was the case in the two weeks before, the result is 3,520.

6th week, 81 g.=812 insects+91 g. grain. In 3 days he ate 34.5 g. =348 insects and 39 g. of grain. The week is calculated at the same rate.

Totals: 373 g.=10,911 insects+91 g. grain.

In December, January, February, March, April and half of November the estimate is that found by 56 tests — 15 g. of weed seeds a day.

ESTIMATE OF THE AMOUNT EATEN IN A YEAR

	By an adult hen		By an adult cock	
	Insects	Weeds	Insects	Weeds.
January	....	465 g.	....	465 g.
February	....	420	....	420
March	....	465	....	465
April	90 g.	450	90 g.	450
May	372	372	372	372
June	600	300	372	372
July	620	310	372	372
August	620	310	372	372
September	450	300	372	372
October	372	372	372	372
November	186	411	186	411
December	....	465	....	465
	3310 g.	4640 g.	2508 g.	4908 g.

For the cock in May, June, July, August, September, October and half of November, and for the hen in May, October and half of November the estimate is that found by 8 tests in October and November — 12 g. of each. In June, July and August when the hen is laying, 20 g. of insects seems a safe average. In 2 tests in July a hen ate 24 g. and 24.6 g. respectively.

For a young bird, if we substitute the figures for his first six weeks for six weeks of July and August in the adult cock's estimate, the result is 2,377 g. of insects and 4,495 g. of weed seeds.

An average of 45 tests gave 22.5 insects to a gram. The highest is 60 in July, the lowest 2 in November. This average is too low for the smallest insects that the birds eat, such as plant lice, were not weighed; besides for the tests large insects were often caught in preference to smaller ones for convenience sake.

One gram of 23 different kinds of seeds were counted; the average was 1,096.

Barnyard grass,	1,250	Evening's primrose,	2,000
Beggar's ticks,	200	Lamb's quarters,	1,000
Black bindweed,	300	Milkweed,	110
Black mustard,	500	Pepper grass,	3,000
Burdock,	100	Pigeon grass,	500
Crab grass,	500	Pigweed,	3,000
Curled dock,	835	Plantain,	2,500
Fringed black bindweed	250	Rabbit's foot clover,	2,000
Dodder,	780	Ragweed,	500

Round headed bush clover,	300	White vervain,	2,500
Smartweed,	900	Water smartweed,	200
Sorrel,	2,000		

Thus a bobwhite cock might eat on an average in one year 56,430 insects and 5,379,168 weed seeds; a hen 74,475 insects and 5,063,520 weed seeds and a young bird 65,001 insects and 4,926,520 weed seeds.

Estimates of the Annual Loss Due to Weeds and Insects.

It is impossible to make calculations as to how much a bobwhite's eating of these thousands of insects and millions of weed seeds is worth to us in dollars and cents. I quote, however, a few estimates of the annual losses due to weeds and insects, so that we may get more of an idea of the importance of the problem.

"Since the total value of our principal field crops for the year 1893 was $1,760,489,273, an increase of only 1%, which might easily have been brought about through the destruction of weeds, would have meant a saving to the farmers of the nation of about $17,000,000 during that year alone." (1) "The simple cost of weed removal along the railways of the State of Ohio is placed by Stair at over half a million dollars per annum." (13) "The weeds found in cornfields annually cost the farmer of Iowa many thousands of dollars." (12) "Minnesota produces annually about 200,000,000 bushels of small grain. A dockage of one pound per bushel (due to weeds) means a loss of 200,000,000 pounds. Had the land been free of weeds the same amount of plant food, moisture and labor would have produced over 3,000,000 bushels of wheat or the equivalent in other grains. This makes an annual loss due to weeds of about $2,500,000 or an annual rental of about 30 cents an acre on every acre on which small grain is grown. Added to this great loss we must include cost of fighting weeds, loss of fertility and moisture, strain on machinery, extra cost of twine to tie up the weeds, freight charges for shipping weeds, etc." (14) In Ontario the "Bureau of Industries for the Province in 1898 sent out a few questions about weeds to its regular correspondents, and others, chiefly those who had done satisfactory experimental work in connection with the Experimental Union. "A large number of answers were received. . . . A number estimate their loss at 25c per acre, and quite a few place it as high as $5 per acre; so considering the whole list and counting labor, with the loss of soil moisture, fertility, etc., we think that $1 per acre is a conservative estimate of the annual loss throughout the Province." (5)

C L. Marlatt in "The Annual Loss Occasioned by Destructive Insects in the United States" estimates the yearly tax chargeable to in-

sects in this country as $795,100,000. (10) "The common schools of the country cost in 1902 the sum of $235,000,000, and all higher institutions of learning cost less than $50,000,000, making the total cost of education in the United States considerably less than the farmers lost from insect ravages. . . . Furthermore, the yearly losses from insect ravages aggregate nearly twice as much as it costs to maintain our army and navy; more than twice the loss by fire; twice the capital invested in manufacturing agricultural implements; and nearly three times the estimated value of the products of all the fruit orchards, vineyards, and the small fruit farms in the country." (3) Prof. H. T. Fernald, Massachusetts State Entomologist, says: "Estimates of the annual loss by insects calculated at 18% are now considered as about correct, and this loss on the basis of the United States government crop estimates for 1906 would be considerably over a billion dollars each year." (2)

If we were wise enough as a people to protect and increase our weed destroying insectivorous birds, they should largely control these enemies of our crops. Bobwhites, if we only had enough of them, ought to save us more than half of our $17,000,000 weed damage, and of our billion dollar insect tax.

Summary

The bobwhite is known to eat 129 different kinds of weed seeds.

A single bird was found to eat as many as 12,000, 18,000 and 30,000 seeds of one kind of weed in a day.

They eat 15 grams, or half an ounce, of weed seed daily throughout the winter.

The known list of insects eaten — 135 — includes many of the most injurious species.

A single bird ate at one meal 568 mosquitoes; another during a day ate 1,350 flies; a third ate 5,000 plant lice, while still another record is 1,532 insects, 1,000 of which were grasshoppers.

Bobwhites eat from 12 to 24 grams of insects daily in the summer.

In a study of the growth and feeding of one bobwhite, it was found that in his third week he ate half of his weight of insects, in his fourth week one third. In the sixth the addition of grain brought it up to one half again. When adult they eat from one twelfth to one sixth of their weight.

An estimate of the average amount eaten by a bobwhite in a year is 2,732 grams, or about 5 pounds, of insects, and 4,681 grams, or about 9¾ pounds, of weed seeds, which are equivalent to 65,302 insects and 5,123,076 weed seeds.

I wish to acknowledge my indebtedness to Dr. C. F. Hodge of Clark University, under whose direction this work was done, for help and suggestions; to Mr. Arthur Merrill of the Massachusetts State Hatchery at Sutton, for assistance in rearing the birds; to Dr. F. M. Webster of the United States Bureau of Entomology, for supplying me with various insects; and to Mr. A. D. Selby of the Ohio Agricultural Experiment Station, and Mr. Geo. H. Clark, Seed Commissioner of the Department of Agriculture, Canada, for sending me weed seeds.

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A UNIQUE INSECT CATCHING MACHINE

By F. C. Bishopp, *U. S. Bureau of Entomology, Dallas, Texas*[1]

The following article is published not because the observations are thought to have any particular value or that the machine described can be utilized practically in the control of the bollworm, but to call attention to a rather unusual digression in mechanical insect destroying devices and with the hope that the idea involved may be suggestive to workers in other entomological fields.

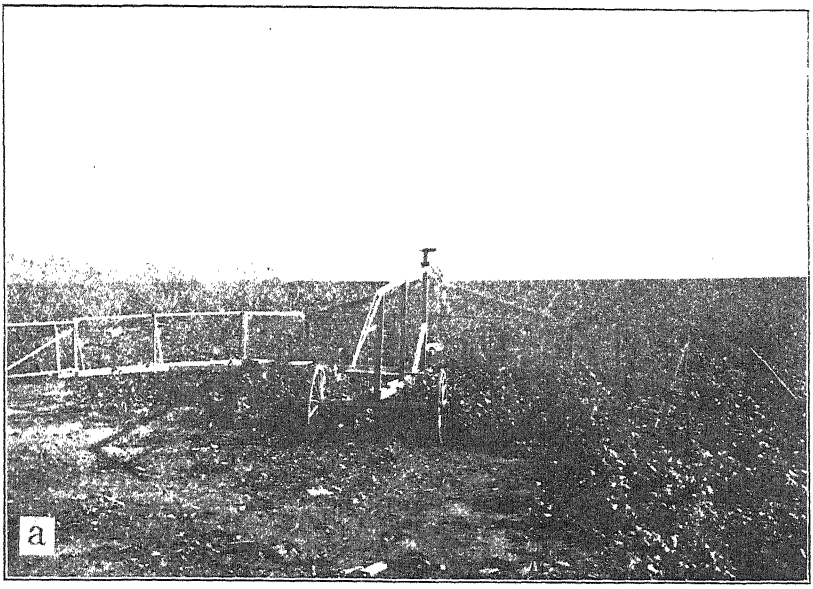
The machine illustrated herewith is the result of the ingenuity of a progressive Ellis County (Texas) farmer in his efforts to discover a method of controlling the bollworm (*Heliothis obsoleta* Fabr.) on cotton. Unlike most of the machines devised for use against the bollworm this one is designed to capture the adult moths instead of the larvæ. While lights are employed to concentrate and destroy the moths, the success of the apparatus is not dependent upon the normal attraction of the moths to light. The machine was evolved by Mr. T. A. Sissom, who is the inventor, from an observation made by him upon the habits of flight of the moths when disturbed at night. The writer has also observed that the majority of the moths when startled at night fly directly upward for several feet, apparently in an effort to avoid striking the cotton plants or other objects.

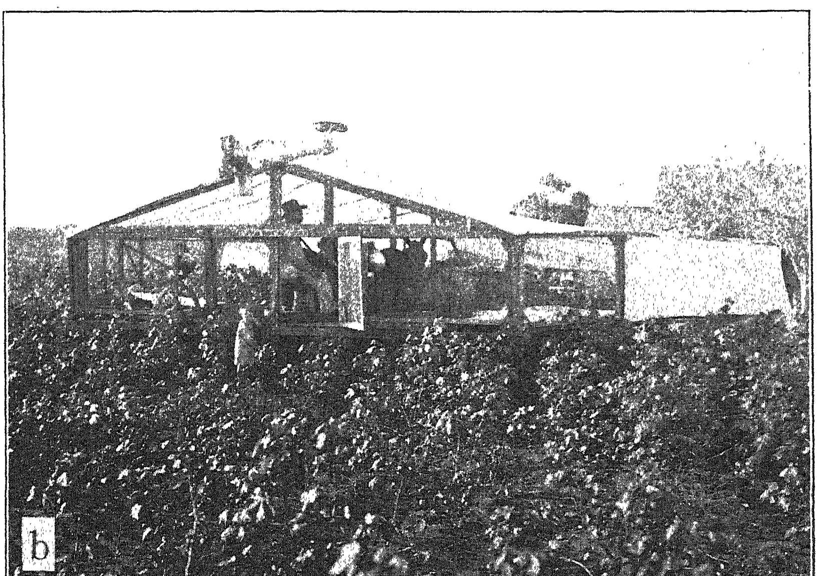
The machine consists of a framework mounted on four wheels. The frame is 36 feet wide in front, 18 feet wide at the back and 28 feet from the front to the back. This frame, except at the back, is covered with domestic, which can easily be put on or removed. The back is screened in.

The machine is pulled by a pair of horses or mules which are hitched between the fore and hind wheels under the canvas, the driver and operator sitting immediately behind the team. The guiding is done by simply rotating a wheel which controls the angle of the front axle.

The front part of the canvas extends down quite close to the cotton but not low enough to strike the plants and thus disturb the moths. Agitators in the form of sacks containing some heavy object, are attached to the frame a few feet back from the front edge of the canvas. These disturb the moths which fly up, strike the canvas and gradually drift toward the three lights at the back of the machine, as the apparatus moves forward. The back part of the machine has a floor high enough to pass over the cotton. This prevents the down-

[1] Published by permission of the chief of the Bureau of Entomology.





Insect Catching Machine: *a*. Front view of machine with cloth covering removed; *b*. Rear view of machine ready for operation; the seat on top may be occupied by a pilot if so desired.

ward escape of the moths when they reach the back of the machine. The upper one of the three lights, each of which has a reflector to throw the light ahead, is situated at the extreme back end of a tapering inverted trough made of screen. Just in front of this light is a large torch the flame of which scorches the insects as they pass backward over it to the stronger light behind. The bottom of the torch container is removed occasionally and the moths emptied into a bag and treated with kerosene to kill those not already dead.

On account of the free flight of the bollworm moths it is difficult to arrange a satisfactory practical test of such a machine on a limited area. During three successive nights in July a 40-acre field of cotton was gone over and 1,440, 2,000 and 860 moths were captured on the respective nights. An examination of the catch made in 3½ hours during the night of July 27th showed the following insects to have been captured: *Heliothis obsoleta* Fabr. 688 (409 females and 279 males), *Loxostege similalis* Guen. 157, *Calycopis cecrops* Fabr. 1, miscellaneous Lepidoptera 72 (including several injurious forms), *Chrysopa* sp. 1,906, Myrmeleonids 11, Tachinids 16, Syrphids 6, Tabanids 12, Sarcophagids 150, miscellaneous Diptera (small) several hundred, *Calacorus rapidus* Say 762, Tettigonids and Jassids (mostly *Diedrocephala coccinea* Forst.) 68, *Podisus maculiventris* Say 2, *Diabrotica 12-punctata* Fabr. 14, Elaterid 1, Bruchids 2.

It was found that many of the bollworm moths captured were newly emerged or gravid females, while with an ordinary trap light only males and exhausted females are usually caught.

It will be noted that a good many beneficial insects were captured notably 1,906 adult Chrysopas. I believe that the majority of these as well as other beneficial forms could be allowed to escape by putting in larger meshed wire at the back end of the machine. This would of course allow the escape of the smaller injurious insects as well.

Despite the large size of the apparatus it is manipulated with great ease except when the wind is blowing. A strong wind renders operation impossible. From 60 to 70 acres may be gone over in one night. Mr. Sissom informed me that the cost of constructing one of these machines is about $80.

As has been suggested it has not been demonstrated that this machine can be utilized practically in the control of the bollworm, but there is little doubt that some injury may be prevented where it is conscientiously used.

NOTES ON RHYNCHITES BICOLOR, FABR.

By Edgar L. Dickerson, *New Brunswick, N. J.*

In this Journal for December, 1909, page 467, Dr. B. N. Gates gives some notes on the abundance of *Rhynchites bicolor* in Massachusetts during the past season. The insect is recorded as common in New Jersey, throughout the state, but in our experience it is somewhat local in its distribution, being very abundant at some points and quite scarce at others. In some of the nurseries where we have had an opportunity of observing roses, in the course of inspection work, we have found little evidence of the insect. At New Brunswick, however, it occurs each year so abundantly on the *Rosa rugosa* hedge on the College Campus that there is scarcely a seed capsule which does not show one or more of its punctures. No effort has been made to breed the insect but certain observations have been recorded which it seems advisable to publish at this time.

As noted in other localities, the insect makes its appearance in May and continues through June and July and is observed first feeding in the buds or opened blossoms. In feeding in the buds the insect inserts its beak through the still closed petals, causing the punctures which becomes so conspicuous when the blossoms open. Rarely, feeding occurs in the tender tips of the shoots where as many as a dozen closely placed punctures have been observed in a single tip. Very few of these tips were found although their wilted appearance made them rather conspicuous. That they were caused by feeding seems quite evident from the fact that no eggs were found in the punctures although a careful search was made for them.

While I have no record of the beginning of oviposition, it continued for some time and in late June the beetles were noted both feeding in the open flowers and in copulation, and oviposition was in progress. The latter operation was observed on more than one occasion and noted to proceed in the following manner:

The work of making the puncture was continued until the full length of the beak — as far as the eyes — was inserted and the final part appeared to be the smoothing down of the sides of the puncture and enlarging the bottom; the whole operation taking somewhat over a quarter of an hour. In working the beetle spread its legs as if to brace itself and the antennæ were extended backward close together against the upper surface of the head. Having completed the puncture, the insect turned about, rested its anal extremity in the cavity, and remained there for about half a minute while it oviposited. Then turning about again it spent slightly more than half a minute in

apparently pushing the egg down into the bottom of the cavity and covering the opening. In this operation the value of the ball and socket like connection of the head with the thorax was evidenced, for without changing its position the insect was able to move its head around from side to side. Whether the covering of the puncture is a secretion of the plant caused by the injury or in part is some secretion of the weevil is not quite evident. At any rate it forms a distinct covering, light in color at first and gradually darkening.

An examination of the seed capsule shows that the punctures extend through the outer covering and sometimes into the bases of the seeds, resting within it and measure 2 mm. in depth. The egg is oval in outline, measuring .9 mm. in length by .65-.70 mm. in width, and is light in color with a yellowish tinge given it by the contents. It rests in the bottom of the puncture with the longest diameter parallel with the direction of the cavity.

Punctures were found in the seed capsules of the blossoms as well as those from which the petals had fallen and as many as 8 were noted in a single one. On several instances two punctures were observed so close together that they extended into each other at their bases and in all such cases only a single egg was found, so that it appeared as if the first egg had been destroyed by the weevil, in the operation of making the second puncture.

Hatching of the eggs began the first of July and by the middle of the month most of them had hatched. No unhatched eggs were found on July 22 when a number of punctured seed capsules were examined, although a very few young larvæ were found as late as early September. The larvæ became well developed by August and soon after the middle of that month many full grown ones were found. By early September most of the larvæ had left the seed capsules, which in many cases had become hard and dry.

THE EFFECTS OF FUMIGATION WITH HYDROCYANIC GAS ON THE HUMAN SYSTEM

By W. W. Yothers, *Bureau of Entomology, U. S. Department of Agriculture*

Owing to the extremely poisonous nature of hydrocyanic gas, the literature on this subject contains many cautions in regard to its use. While I believe these are on the whole justifiable, they make the uninitiated unduly afraid of the dangers. I doubt if there has ever been a single death from fumigating—at least from fumigating orange trees. The experience of the workers on the White Fly Investigations of the Bureau of Entomology in Florida shows that only rarely

does the gas cause sickness. In the entire three seasons' work this occurred only five or six times.

In the winter of 1907–1908 in fumigating over three thousand trees eight hundred of which were large seedlings, two men quit work because the gas made them sick. These men operated the pulley ropes which lifted the edge of the tent from the ground and raised it to the top of the derrick. Just as soon as the edge of the tent is raised the gas comes out and the men who operate the pulley ropes being nearest the opening get more of the gas than the other men. The trees were very large, requiring from four to six pounds of cyanide. No note was made as to whether or not the night was calm or on the condition of the tents as to dampness which largely determines the leakage of gas during exposure.

Only one instance happened in the season of 1908–1909 in fumigating about a thousand trees. The night of January 11, 1909, was so far as one could determine absolutely calm. The trees were fairly large, requiring from two to four pounds of cyanide. We changed the tents every 40 minutes. The tents being somewhat damp were very tight so that little gas leaked out during the period of exposure. Five men became sick on this night. One of these emptied the residue from the crocks and held his head over the residue as it was being poured out so that he breathed the escaping gas. This, of course, was entirely unnecessary. The other four operated the pulley ropes as did the men who became sick in the tests of 1907–1908. Two became sick and were relieved by two others who also soon were affected.

On this night I relieved one of the men operating the pulley ropes. In a short time my heart beat much faster than the work seemed to justify, then dizziness overcame me and I stretched out under an orange tree. In about 5 minutes it became necessary to go to stool. After this a nauseating feeling remained for some time followed by chills and trembling of the muscles and almost total loss of muscular strength. A vicious headache terminated these symptoms. These symptoms were in the main common to all the affected persons. In one or two instances vomiting occurred.

In October, 1909, we were fumigating some trees about ten feet in height, using a 25 per cent increase over the dosage given in Bulletin 76 of the Bureau of Entomology and moving the tents every 25 minutes. The shortness of the exposure gave little time for the gas to leak out and also the tents were much tighter than those used on former occasions. There was no breeze. During the first night no one became sick although the gas was very strong. However, during the second night all of us got sick. One man fell over and the

rest of us were compelled to postpone the work for a few minutes. Our hearts thumped against our breast bones and one fellow vomited. All of us were well on the following morning and felt as if nothing had happened. On this night we did not realize the importance of hurrying away from the tent as soon as it was raised with the poles. It was unnecessary this time and could have been easily avoided.

The only object of writing these experiences is to enable one to tell when they are getting too much gas. If the heart beats very rapidly it is time to get away for a while. A small amount of gas is not uncomfortable to a fumigator and is seldom noticed at all. Sometimes a prolonged exposure to a small amount of gas causes coughing which is nothing serious. If tents are left on the trees the proper length of time and those men nearest the tent when first raised take proper precautions, there is little or no danger and the poisonous fumes do not interfere with the process at all.

Scientific Notes

Simulium and Pellagra.—We learn from the London *Times* through a recent issue of *Science*, that Dr. Sambon has proved that maize is not the cause of Pellagra, the blood thirsty *Simulium reptans* being responsible for the dissemination of this infection. It is hardly necessary to remind our readers that only a few years ago the important part played by Diptera in the dissemination of human diseases was practically unknown. The order must now be considered as one of the most important from an economic standpoint, especially because of the part flies play in the spread of disease.

Oyster Shell Scale (*Lepidosaphes ulmi* Linn.).—The paper on this insect by Mr. Cooley, was very interesting. We have entirely cleaned badly infested trees by spraying with a lime-sulfur wash and then failed on adjacent trees, no matter how carefully the application was made, though we usually succeeded in reducing the numbers of the pest. The experience of the last six years convinces us that the late spring application is by far the more effective. One season we treated about half an acre of large, imported lilacs which were nearly dead because of injury by the oyster shell scale. A very thorough application was given when the lilacs were in bloom, and an examination in the fall showed that 90% of the shrubs were free, the remainder having a few scales on one or two shoots only. An application of kerosene emulsion to 67 infested poplar trees resulted in practically cleaning the trees, as shown by an examination the following winter. C. R. Neillie, *Cleveland, Ohio.*

Larch Sawfly, a Correction.—I find that in the short paragraph of my paper on the Larch Sawfly (page 149) that the stenographic report is not quite what I said and is likely to mislead. I did not say that no males were present, but that larvæ were reared from females, no males being present; and that, in a total of several thousand specimens .3 per cent. were males and the rest females. C. Gordon Hewitt.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1910

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints may be obtained at cost. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—EDS.

We include in this issue, a paper extending somewhat beyond the scope of the JOURNAL, yet nevertheless of great interest to economic entomologists, since it gives in compact form, many very serviceable facts about an extremely valuable bird. The data upon its vegetarian food is so closely interrelated with its animal diet that it seemed inadvisable to attempt to separate the two. We are confident that many entomologists will find it very convenient to have this data accessible.

The passage of the Insecticide Act of 1910 marks an important and most timely advance in the right direction. Heretofore almost any compound containing arsenate of lead might be sold under that name. After January 1st next, all preparations of this recently developed and extremely valuable insecticide falling below a specified standard, are debarred from interstate commerce. The recent great advance in work with insecticides, accompanied by enormous increases in the demand for materials, has resulted in a number of manufacturers entering this field. We are convinced that the majority are content to place upon the market excellent preparations at moderate prices. Occasionally there is a rogue who preys more or less directly upon the reputation of others. For example, one brand of arsenate of lead sold in the local market under a trade name for twenty-five cents a pound contains only four to five per cent. of arsenic oxide, while another brand containing fourteen to fifteen per cent. arsenic oxide, sells for fifteen cents a pound. Many a man fails to discriminate between the two and accepts the dealers "just as good" at face value, apparently forgetting that there may be a large profit in pushing the lower grade goods. This substandard material, with the above mentioned national law in force, will soon be driven from the market or confined to a very limited field. Aside from the possibilities of fraud mentioned above, there is a great gain in establishing standards for recognized compounds. It prevents confusion and lessens the danger of unsatisfactory results following spraying operations.

Reviews

The Hibernation of the Boll Weevil in Central Louisiana, by WILMON NEWELL and M. S. DOUGHERTY, Louisiana Crop Pest Commission, Circ. 31, p. 163–219, 1909.

In 1905 and '06 the Louisiana Crop Pest Commission carried on extensive experiments on the hibernation of the boll weevil at Keachie, La., in coöperation with the Bureau of Entomology, which have been partially reported by Hinds and Yothers (Bull. 77 Bur. Entomology). Further experiments were felt to be necessary and these were arranged at Mansura, near the center of Louisiana in the fall of 1908. The authors are entirely warranted in their statements that "The results of these experiments from the standpoint of the Louisiana planter at least, are of far more practical importance than those of any like experiment previously made." The object was to determine what percentage of weevils survive the winter, and at what rate they left their winter quarters in the spring. A series of large wire screen cages 8 x 8 x 6 ft. high were constructed in which were placed materials in which the weevils commonly hibernate. From 1000 to 1200 weevils were placed in each cage. A series of cages was installed to determine the effect of starvation in the fall by enforced hibernation. The weevils were placed in the first cage September 28 and a similar cage was started each week until December 21. A comparison was also made of a cage under normal conditions and one located in a swamp in a light growth of timber. In another cage a large tree-limb bearing Spanish moss was placed to determine its value as a hibernating quarter.

It has been previously stated that the weevils seek hibernating quarters when a mean daily temperature falls to 60° F., but the authors' observations show that the weevils were not inclined to enter hibernation till December 8, altho the mean temperature for ten days preceding was 43°. The writers believe that some of the weevils seen on the sides of the cages remained there thruout the entire winter. In the five cages first started the greatest death rate occurred during the warm weather prior to the date of hibernation. Commencing on February 15, daily observations were made to determine the number of weevils leaving hibernation and these were tabulated in detail. In general, it may be said that the tabulation of the data and results of these investigations is most admirable and leaves nothing to be desired on the part of the student who wishes to give them detailed study.

In the 16 cages there were 16,281 weevils, 3,360 of which or 20.63 per cent survived the winter. As a result of a comparison of the percentage surviving in the cages in which the weevils were confined at different dates in the fall, it is shown that where cotton plants were destroyed before October 15, only 3 per cent survived; where it was destroyed between October 15 and 27, 15 per cent survived; from November 1 to 25, 22 per cent survived; from November 30 to December 7, 28 per cent survived, and if the destruction of the plants were postponed till after the middle of December, over 43 per cent survived.

It was found that in the average winter quarters 20 per cent of the weevils survive, but where Spanish moss was furnished, 27.96 per cent emerged from hibernation. A comparison of the cages placed in a swamp

and in normal conditions showed practically no difference in the mortality resulting.

The earliest weevil emerged on February 21; the last one on June 29, the period of emergence covering 129 days. The earlier the weevils were confined in the fall, the earlier the majority of them emerged in the spring. This shows very clearly the value of early destruction of the stalks in the fall in connection with poisoning with dry arsenate of lead as they are poisoned much more easily in the spring. It is shown that weevils hibernating in moss emerge much later than under natural conditions, 50 per cent emerging over a month later.

The same is true of weevils hibernating in swamps and it is shown that "the weevils hibernate in cool and shaded locations do not leave hibernation till the summer heat has risen sufficiently for these places to be warm to the temperature reached in the fields one to three weeks earlier."

The average time the weevils lived in hibernation without food was 150.7 days. The weevil which lived the longest without food was placed in a cage September 28 and emerged June 9, 255 days later. A detailed study of the relation of the time of emergence from hibernation to the time when the weevils were deprived of food in the fall, shows that when all cotton plants are destroyed by October 1st the average weevil must live 183 days without food before emerging from hibernation, but when the plants are left until December 21 the average weevil has but 94 days to remain without food before leaving winter quarters. The average length of life of the weevils after leaving hibernation was 10.7 days, the longest lived individual living 144 days. The life of the weevils becomes shorter after leaving hibernation as the weather becomes hotter.

The weather conditions during the winter in which these investigations were made are considered in detail and the authors conclude that "We might therefore be justified in supposing that the normal winter would be survived by a slightly smaller percentage of the weevils, though an average difference of 3.1° in temperature could hardly be expected to materially increase the winter mortality among the insects," and "In the average season the weevils would emerge from hibernation somewhat more quickly during May than they did in this experiment. The winter was an exceptionally dry one tho not far from normal so far as the temperature was concerned." They conclude that the number of weevils living thru the winter of the experiment was above the average, but that the rate of emergence from hibernation was normal.

E. D. Sanderson.

Lead Arsenate, by J. K. Haywood and C. C. McDonnell, U. S. Dep't. Agric., Bur. of Chem., Bul. 131, p. 1–50, 1910.

This interesting bulletin is in three parts. The first is on the results of a chemical examination of the composition of lead arsenates found on the market. Analyses of fifty different samples produced by fourteen different firms are given. That the names of these firms are not given is to be regretted, though the reasons for this are obvious, for anyone planning to buy arsenate of lead would probably avoid purchasing of manufacturer J. of the list, for example, if he could learn for whom J. stands.

On the whole, the analyses show a considerable variation in the amount of arsenic present and too much of it is in a soluble form, in many cases.

As a consequence, spraying with some brands might prove inefficient, simply because of the small amount of poison present, or might cause injury to the foliage because of an excessive amount of soluble arsenic. It is noticeable that there is a great difference in the amounts of arsenic and lead present in the different samples analyzed. This should make a great difference in the preparation of the material for application to the trees. In one case noted, the material which is evidently in the form of a dry powder, contains more than twice as much arsenic as in another sample which is in the form of a paste and contains over sixty per cent. of water. To prepare such widely differing samples by the same formula for spraying would be liable to lead to most divergent results.

The second section of the bulletin treats of "home-made" lead arsenate and the chemicals entering into its manufacture. Analyses of samples of lead acetate, lead nitrate and sodium arsenate gave, for the most part, quite satisfactory results, the latter showing the greatest variations in composition. Attention is called to the point that when sodium arsenate having an unusually high per cent of arsenic is used, it is possible that ordinary formulas would fail to provide lead enough to combine with all of this, thus leaving a soluble salt of arsenic in excess in the spray to endanger the foliage.

Comparison of numerous published formulas shows considerable variation in the amounts of the different substances to be taken, leading in some cases at least, to the addition of materials which will be in excess of the amounts needed. To avoid this, directions for preparing lead arsenate both with lead acetate and with lead nitrate are given, for the different usual grades of sodium arsenate. It is not probable, however, that the average sprayer will take the trouble to test the material to determine when the lead comes to be present in excess, much as this is to be desired.

Until the present time, the general preference seems to have been in favor of using lead acetate instead of lead nitrate as a material. Comparative experiments here given, seem to favor the latter as being slightly cheaper, slightly more poisonous and the lead arsenate produced by its use settling much more slowly than that made from the acetate. This would seem to differ from the results obtained by Colby, who found (if the recollection of the reviewer be correct) that the arsenate of lead made from lead nitrate settled much more quickly than that made from the acetate, and it would now seem desirable to repeat these tests. An added point not mentioned in this bulletin is that after standing a while, the acetate becomes delequescent, thus changing its value.

The third, and in some regards the most interesting section of the bulletin is devoted to the action of lead arsenate on foliage, the results of investigations in which Mr. A. L. Quaintaince of the Bureau of Entomology, co-operated with the authors. Starting from quoted statements of the safety of the material at almost any strength, the fact that injury results in some cases despite these views, led to inquiries as to the cause, atmospheric conditions as the explanation seeming to be the most probable. These were studied for six months in 1907 and 1908 in connection with the spraying. The conclusions reached are, of course, tentative, but so far as they go, indicate that more or less decomposition of the lead arsenate was caused by the presence of various salts in the water, particularly sodium chlorid and perhaps sodium carbonate. Weather conditions also appeared to have some effect, injury results to the foliage (and fruit) following an application

followed by clear hot days and no rain, while spraying followed by cool days and rains resulted in no injury. The suggested explanation is that in the former case the dews at night would be sufficient to moisten the material and the hot sun the next day would produce conditions needed to dissolve the greatest amounts of arsenic, while if rain were to follow, the sodium chlorid and carbonate would be washed out, leaving nothing to cause the breaking up of the lead arsenate.

The bulletin is a valuable one and very suggestive for those accustomed to looking at such subjects from their chemical aspects. It is somewhat questionable, however, if the average fruit grower might not desire a more direct series of statements as to the conclusions reached, which would guide him better in his subsequent spraying. H. T. F.

Ants, their structure, development and behavior, by WILLIAM MORTON WHEELER, Ph.D., Professor of Economic Entomology, Harvard University; Honorary Curator of Social Insects, American Museum of Natural History. New York, Columbia University Press, 1910, p. I to XXV; 1–663; 286 figures.

This is a comprehensive work written by an acknowledged master in the group and dealing with the structure and biology of these extremely interesting forms. The reader needs only to refer to the 70 closely printed pages of the bibliography to gain some idea of the vast amount of labor in digesting these almost innumerable and widely scattered records and co-ordinating them with observations extending over a decade.

The author considers that the social relations, attaining their "richest and boldest expression in the ants," arouses interest, owing to there being an undeniable resemblance to human conditions. The character of this volume is well indicated by chapters devoted to ants as dominant insects, the external and internal structure of ants, development, polymorphism, history of myrmecology and classification of ants, their distribution, fossil ants, habits in general, ant nests, driver and legionary ants, harvesting ants, relation of ants to vascular plants, fungus growing ants, honey ants, guests, ecto and entoparasites, slave makers, the instinctive and plastic behavior of ants.

Economic entomologists will be particularly interested in the chapter treating of the relation of ants to plantlice, scale insects, tree hoppers and caterpillars. The discussion, while comprehensive, is not unduly extended. Here, among other interesting notes, we find a very lucid account of the aphid cornicles and their functions. The extermination of noxious species is concisely discussed in an appendix. The value of this important work is greatly increased by a key to the subfamily, genera and subgenera of the North American Formicidæ, together with a list of the described species. The author is to be congratulated upon having produced an authentic, scholarly discussion of a highly interesting group.

Corn Weevils and Other Grain Insects, by R. I. SMITH, N. C. Agric. Exp't. Sta. Bul. 203, p. 1–27, 1908.

This popular bulletin discusses in a summarized manner the more important grain insects. The author wisely emphasizes the value of preventive

measures, advising early threshing and tight sacking of small grains. Burning sulfur, 2½ pounds to 1,000 cubic feet, is especially advised in cleaning granaries, though it can hardly be recommended for those containing grain, since this fumigation will prevent germination. The standard fumigant, carbon bisulfid, the author finds, must be used much stronger than usually recommended.

Shade Trees, by E. A. START, G. E. STONE and H. T. FERNALD, Mass. Agric. Exp't. Sta. Bul. 125, p. 1–64, 1908.

This excellent general bulletin gives much practical information to the tree lover. The entomologist will be interested in the discussion of the care and protection of trees, especially that part relating to tree surgery and the effects of gas and electricity on trees. Summary accounts are given of a number of the more important insect enemies of shade trees.

A Chemical Study of the Lime-Sulfur Wash, by L. L. VANSLYKE, C. C. HEDGES and A. W. BOSWORTH, N. Y. Agric. Exp't Sta. Bull. 319: 383–418, 1909.

The general bulletin on the chemistry of the lime-sulfur wash is something entomologists have been desiring for several years. Dr. VanSlyke and his associates present in this publication, data of great value to those recommending this valuable insecticide and fungicide, since he gives in concise form the different effects from prolonged boiling and those obtained by employing different proportions of the essential constituents. The data relating to the effect of Magnesium shows the deleterious effects following its employment. This bulletin gives a series of facts which may well be employed in determining the value of the various brands of commercial lime-sulfur washes.

Concentrated Lime-Sulfur Mixtures, by P. J. PARROTT, N. Y. Agric. Exp't Sta. Bull. 320: 419–38, 1909.

This is a discussion of the concentrated lime-sulfur mixtures, from the entomologist's standpoint, being based upon the results given in the preceding bulletin and largely supplemental thereto. The author finds little of insecticide value in the sediment of certain concentrated washes and advises the use of the Beaumé scale for testing the strength of the preparation. The table of dilutions will prove most helpful to fruit growers.

A Handbook of the Destructive Insects of Victoria, by C. FRENCH, Prt. 4, p. 1–195, with 33 colored plates; Osboldstone & Co., Melbourne, 1909.

The fourth part of this interesting and well known series contains notices of a number of injurious species, and departs somewhat from the preceding volumes in discussing some of the forest tree pests. Our nursery inspectors will be particularly interested in the regulations governing the shipment and sale of fruit and vegetables, given at the beginning of the volume, while the somewhat extended accounts of the two fruit flies noticed, will appeal to entomologists having to deal with their allies in this country. The notices of

the various species are invariably illustrated by rather well executed colored plates showing the various stages of the insects and their work, and in some instances illustrating parasites. It is interesting to note that the horse bot fly, *Gastrophilus equi* Fabr. is becoming abundant in that section of the world. The concluding pages are occupied by a series of brief accounts, likewise illustrated with colored plates, of a number of Victorian birds, the author emphasizing their economic value, particularly as destroyers of insect life. The final pages are devoted to a brief discussion of insecticides. The lime-sulfur wash and miscible oils appear to be unknown in Victoria.

Insect Depredations in North American Forests, and Practical Methods of Prevention and Control, by A. D. Hopkins, U. S. Dep't Agric., Bur. Ent. Bull. 58; Prt. 5, p. 57–101, 1909.

This is a summarized discussion of insect injury to forests, with brief notices of some of the more destructive species affecting the important trees or their products. There is also an interesting dissertation on the interrelations existing between insects and forest fires. The author estimates the total loss on forest products in the United States at $100,000,000. Some pages are devoted to the principles to be observed in controlling forest pests, with several accounts of instances where they have been successfully applied. The author advocates the utilization of the natural enemies so far as possible. He rightfully emphasizes the importance of more systematic biologic work to give a scientific basis which may be used in devising practical methods of control, insisting that the former is a necessary preliminary. This bulletin gives in small compass, a large amount of very suggestive information. The appended list of publications relating to forest insects, will prove of material service to students of the subject.

The Pear Thrips and Its Control, by Dudley Moulton, U. S. Dep't Agric., Bur. Ent. Bull. 80, Prt. 4, p. 51–66, 1909.

This most excellent, detailed account with a number of original illustrations, gives an extended discussion of a new fruit pest, *Euthrips pyri* Dan. This insect is believed to have originated either in Europe or China. The remedial measures advised are plowing and timely spraying with a contact insecticide. The tabulations and text are both admirable and the publication might well be adopted as a model in many respects.

The Raspberry Byturus, by W. H. Goodwin, Ohio Agric. Exp't Sta. Bull. 202: 174–86, 1909.

The commendable, detailed account with a number of original illustrations, and especially strong on the biology, is based on careful field investigation as well as a study of the literature. Heavy applications of arsenate of lead are advised. A bibliography is appended.

Current Notes

Conducted by the Associate Editor

Dr. Raymond C. Osborne has been made Assistant Professor of Zoölogy in Barnard College.

Mr. Charles R. Jones, formerly of the Bureau of Entomology, and located at Dallas, Texas, has accepted the position of Entomologist of the Philippine Islands, with headquarters at Manila, P. I.

Mr. Alfred B. Champlain, formerly assistant in the Division of Economic Zoölogy at Harrisburg, Pa., began his work April 1st in his new position as assistant in entomology at the Agricultural Experiment Station, New Haven, Conn.

Mr. Merrill A. Yothers has recently been appointed assistant entomologist at the Agricultural Experiment Station at Pullman, Washington. Mr. Yothers formerly held a similar position at the Michigan station.

Rev. J. S. Zabriskie, well known as an entomologist and microscopist, and a member of the Brooklyn Entomological Club, died at his home in Brooklyn April 2d, at the age of seventy-five years.

At the Bussey Institution of Harvard University, Forest Hills, Mass., a course of illustrated lectures in economic entomology and genetics has been arranged for Sunday afternoons at four o'clock, beginning April 19th and closing May 29th. The entomological lectures are as follows:

April 10th, "Insects as Carriers of Disease. I. The House Fly and its Allies," by Professor W. M. Wheeler.

April 17th, "Insects as Carriers of Disease. II. Mosquitoes and their Allies," by Professor W. M. Wheeler.

May 8th, "The Gypsy and Brown-tail Moths," by Mr. C. T. Brues.

May 15th, "Insects Injurious to Elm Trees," by Mr. C. T. Brues.

The staff of the Texas Experiment Station, located at College Station, Tex., has recently occupied the new Administration Building, lately erected at a cost of about $47,000. The building is of modern fire-proof construction, of two stories and equipped with all modern devices. The upper floor is occupied by the chemical department, where special apparatus is installed to prevent the spread of fire. All floors in the laboratory are of concrete and all rooms are connected by fire-proof doors. On the lower floor are the offices of the Director, Agriculturist, Feed Control Bureau, Plant Pathologist and Entomologist. The Entomologist of the Station, who is also State Entomologist occupies a commodious office and laboratory. The basement of the building contains storerooms for all Departments. The installation of the records of the research work conducted in the Station, in a building thoroughly protected from fire, is a step well worth emulation by other institutions of a similar kind.

Mr. Harper Dean, formerly connected with the Bureau of Entomology, Cereal Crop Insect Investigations, resigned on March 1st to accept the position of Agricultural Editor of the *Semi-Weekly Express* published at

San Antonio. In his new field Mr. Dean has opportunity for serving a large part of the agricultural population of Texas. Mr. Dean's new work is already making a creditable showing. Considerable space in the *Semi-Weekly* is regularly devoted to timely articles on Economic Entomology.

The Minnesota State Entomologist, by means of an appropriation given him by the last Legislature, has had prepared and distributed to all the schools of Minnesota, colored charts showing some of the more common injurious insects of the state, some beneficial insects, and some useful birds. The chart is 36 inches by 46 inches, made to hang on the wall of the school room. Under each colored figure is descriptive text, giving briefly the economic relation of the insect or the bird in question to the farmer or orchardist. Over seven thousand of these charts have already been distributed to Minnesota schools.

The Entomological Division of the Minnesota Experiment Station is now publishing a monthly leaflet, or journal, containing timely items of interest, advice and suggestions to farmers, housekeepers and gardeners, mailed free to any citizens of Minnesota who request it. This is not a bulletin, but more like a circular. Its aim is to get timely advice and news of insect conditions to the Minnesota agriculturists during the growing season, and is to be published and issued the first day of May, June, July, August and Semptember.

The increased interest in Entomology is shown by the following statistics from Prof. H. F. Wickham of the University of Iowa. Last year he had an increase in his classes of about 50 per cent over the best previous record and this year shows a further advance of 40 per cent over last. He now has close to 100 students taking work in entomology, though the courses are entirely elective.

CORRECTION FOR LEGEND ON PAGE 115

Fig. 6. Germination of seeds at different temperatures by DeCandolle, as given by Abbe, original. .———. *Lepidum sativum;* ———x *Sinapsis alba;* ——— — — ——— *Zea mays;* — — — — *Linam usitatissimum;* ——— — ——— *Trifolium repens;* . . . . . Melon, cantaloupe.

Mailed, June 15, 1910.

JOURNAL

OF

ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 3 AUGUST, 1910 No. 4

THE MAKEUP AND VALUE OF EXHIBITS AT STATE AND COUNTY FAIRS

By H. A. GOSSARD, *Wooster, Ohio*

The Ohio Experiment Station has probably tested the value and scope of fair exhibits as an educational agency as thoroughly as any agricultural institution of its kind in the country and far more thoroughly than most. The Station made an exhibit at the Cotton States Exposition in New Orleans in 1884, sending a collection of grasses. A more representative exhibition was given at the World's Fair at Chicago in 1893, several departments being represented. Another general and representative exhibit was made at the Paris Exposition. Exhibits seem to have been made at all the State Fairs since the Station was organized. The first exhibit, made at a county fair, was at Wooster in 1891. Exhibits were furnished to various county fairs according to the accidents of circumstances until 1905, in which year the general policy of making exhibits at the county fairs under an organized system was adopted.[1] During that year an exhibit was made at seven county fairs. The exhibit was shown at six fairs in 1906, at seven in 1907 and at eight in 1908. In 1909 there were two sets of exhibits, the one being practically a duplicate of the other, and it was therefore possible to show in two different counties on the same set of dates. Twenty fairs were visited this season, covering a total railroad mileage of 2108 miles.

In the beginning of the exhibition work, the displays were small and consisted of such products as might have been shown by any

[1] For fuller information regarding the exhibition work of the Ohio Station see Circular No. 101.

good specialists along agricultural and horticultural lines. Today the exhibit is large, as such displays are usually rated, and it is our special object to exhibit not only such products as were early shown, but to marshal in some manner in one impressive object lesson the cumulative results of years of uninterrupted investigation of specific problems. These exhibits, illustrating long period research, are best shown by the Departments of Soils and of Agronomy.

The space occupied by the Station Exhibit at the State Fair in 1909 was 96.5 x 73.5 feet. Along the walls, some of the exhibits, as in the case of the Department of Forestry, rose to a height of 50 to 60 feet. One of the table allotments was to the Department of Entomology and was about 60 feet long. This bench space, together with that across the ends of the table, gave us a table frontage of about 75 feet. The accompanying illustration, Plate 21, shows the general effect of the entomological exhibit. The enlarged bromide pictures seen in the illustration extended to a height of 10 or 12 feet from the platform, some spaces being left between the frames to enable the onlooker to catch a glimpse of the exhibits on the opposite walls; thus we thought to safeguard against any one leaving the hall under the impression that he had seen everything before he had seen one half of the complete exhibit shown by the Station. The Station supervisors of the exhibits usually demand a space equivalent to a tent not smaller than 40 x 60 feet as a condition for installing one of the county displays. The only expense imposed on the County Fair Associations as a condition for such installation is that they shall furnish sufficient space in a building or waterproof tent; that they shall thoroughly advertise it in advance of the fair; and that they shall defray all expenses of drayage and furnish carpenters and mechanics, as needed, to help put the exhibit in place; and again workmen to assist in tearing it down and packing it, at the conclusion of the fair.

Though, for a time, we were in some doubt as to the economy of this method of extension work, we have concluded that the results justify the expense. Certain it is that the general public take more kindly to this form of expenditure than to many others. The visual demonstration of results attained excite the interest and clinch the recollection in a way that can scarcely be attained by any other method of instruction. Many farmers now go to the State Fair for the express purpose of spending two or three days studying our exhibit and say that, in educational value, an examination of it rivals, or exceeds, a visit to the Station farm at Wooster. There is no other way by which we can get a visual demonstration of our work and its results before so many people in so short a time. The attendance at our State

Exhibit of the Department of Entomology of the Ohio Experiment Station at the State Fair

Fair ranges from 15,000 to 55,000 persons per day, most of whom give more or less attention to the Station's display. Also some of our county fairs are quite largely attended. The following figures record the admissions in round numbers to several of our county fairs at which our exhibits were shown in 1909. These figures are for the entire term of the fairs and not for single days:

39,000	9,000	20,000	26,000
15,000	19,000	9,000	30,000
25,000	16,000	19,000	21,000
			46,000

The admissions for a single day at one of these fairs were estimated to be 20,000, while the recorded admissions in one day at another exceeded 16,000. There is a somewhat greater probability that a larger percentage of the attendants at a county fair, than at the State Fair, will examine the Station's exhibit, because there are fewer other attractions to enter into competition with it. When we first commenced making these displays at county fairs, we sometimes had difficulty to hold our ground against the horse races, but our exhibition work has now been so generally exploited over the state that most of the visitors have their expectancy aroused and are curious to see the exhibit before they come to the fair. But the county fair visitors seem, on the whole, not quite so discriminating and more unlikely to comprehend the full significance of the exhibit, without help, than those composing the State Fair crowd. Many of our County Fair Associations now regard the Station Exhibit as one of their star attractions and one of the secretaries writes, in making application for the exhibit this year, that he would rather ask his association to pay $200.00 for the exhibit than to miss having it again.

The entire work of arranging for and caring for these exhibitions is in the hands of the Department of Coöperative Experiments, and the only labor devolving upon the Department of Entomology in connection therewith is to prepare the Entomological Exhibit and keep it in repair from year to year. The repairs are usually comprised in the replacement of a number of damaged specimens, revarnishing some of the cases, cleaning up the glass entering into its makeup, and in like small, but tedious operations. The numbering and inventorying of the different pieces and of the shipping cases is all attended to by the Department of Coöperative Experiments according to a carefully devised system. In case of wreckage on the road, the inventory would furnish the basis of settlement for the damage claim, and in case new men are employed to work with the exhibit, they can

determine at once from the numbered pieces into what shipping cases or boxes they are meant to be packed. From a legal standpoint the Entomological Exhibit always remains the property of the Department of Entomology and, while the Department in charge of these Fair Exhibits is held accountable by the Station authorities for a careful administration of the trust committed to it, no legal claim for loss would obtain against the Coöperative Department for damage sustained by the exhibit while in its care.

Always at the State Fair, and occasionally at a county fair, some member or members of the entomological staff of the Station are present with the exhibit for the purpose of assisting in installing the same and to answer entomological queries; but at nearly all of the county fairs this work is performed by employes of the Coöperative Department, who try to acquaint themselves with the different features of the exhibit so as to be able to answer the questions most likely to be asked concerning it. Such questions as they are unable to answer are noted down, and sent to our office at Wooster, from which a reply is sent by mail. The large number of letters of inquiry we receive direct from constituents soon after the exhibit has been shown at their county fair, furnishes evidence that many people have learned for the first time that there is a public information bureau supported by the government and state, which they have a right to consult by mail for information which they previously supposed to be inaccessible to them.

Dismissing these preliminary observations of a general nature, let us now consider more specifically the Entomological Exhibit. We have not yet attained our ideal in the makeup of the display and probably never will fully reach it. We find it still more difficult to get a satisfactory setting-up of the different features in the space that often falls to us in county buildings and tents. We work toward the unit idea in preparing the exhibit, but questions of expediency constantly interfere with perfectly working out the plan. We try to group in one place, when setting up, those insects which affect small grains, again together those which affect fruits, and likewise, those which affect garden products, etc.; these displays again being subdivided into cases of insects which, for instance, attack wheat, or corn, or apples. So far as possible the enlarged bromide pictures are placed just behind and above the insect displays which illustrate similar subjects. However, other factors than those of mere utility have seemed to us to deserve more or less consideration in preparing and displaying such an exhibit. A case of brilliant butterflies and moths will sometimes cause the passerby to stop for a closer view, and he

generally then begins to look, with some interest, over the other cases which he would not have noticed at all had not his progress been arrested by this flash of color and beauty, which it would be very hard to fit into any special place in a purely utilitarian scheme. Our Riker series of life histories are especially serviceable in this way; yet any one who undertakes to build up a large collection of these life-histories will make slow progress if he does not take at once whatever offers and whenever it can be taken. As the collection enlarges one can, of course, discard the less interesting sets of mounts and can reach some sort of system in grouping them for exhibition. But though our collection has been the gradual accumulation of several years of work, we have thought best to use all material of this sort that we were able to prepare, notwithstanding the fact that the interest attaching to many of the sets is purely biological. The cotton boll weevil and the Texas fever tick are of little or no interest to the Ohio farmer from a utilitarian standpoint, but we had so many inquiries if we had them on exhibition that we have added the full life series of each, as well as of the gypsy moth and of the brown-tail moth, none of which are found in the state, but the latter two of which may appear in our borders at any time. Some of the sets have little value except as beautiful specimens and illustrations of purely biological principles. Again, in setting up the exhibit, we always give consideration to the æsthetic idea as well as to the utilitarian grouping scheme, and an effort is made to keep the general effect of the exhibit, as a whole, in harmonious balance. In fact the attractiveness of our exhibit is partially due to our steadfast resolution not to permit the economic idea or any other ironclad notion to completely dominate the makeup or the arrangement of the exhibit. It is difficult to properly distribute credit among the different workers whose ideas have entered into the composition of this display. To consider them chronologically, we must mention that a few cases were in order when the writer entered upon his duties as Entomologist of the Ohio Station, and there were evidences that some exhibition work had been prepared several years before this. Some of these old specimens are still in the exhibit and serviceable, though in new cases, and in new groupings to harmonize with the general plan of the expanded exhibit. Some good material was prepared under Professor Parrott's supervision and, transferred to new cases, is still in use. Mr. Houser has contributed some good pieces to it. Mr. Herbert T. Osborn has prepared most of the Riker life-history sets and many of the other cases of entomological specimens. His patient and painstaking labor upon it deserves high praise, for it carried to com-

pletion many cases that must have remained fragmentary except for his never-tiring perseverance. Mr. Goodwin has contributed so much to the exhibit, from many standpoints, that it would be hardly recognizable as the Ohio Entomological Exhibit if his work on it were eliminated. Most of the bromide enlargements were made by him, and the various mechanical contrivances by which it is quickly put into place and again torn down and quickly packed are, for the most part, the products of his ingenuity. The work of the writer upon it has consisted in giving it general direction, outlining the various features of which it should consist, suggesting and approving methods of working out the various details, etc.

Categorically considered the parts of the exhibit are are follows:

Insect Cases

There are 24 cases of insects in plain stained boxes 14 x 22 inches, papered inside and fitted with glass covers. (Fig. 1, Plate 22.) Six of these cases are duplicates, one set of six being with each of the two County Fair Exhibits, which as we have already stated, are shown at two different fairs on the same dates.

The contents of the cases are as follows:

1. Some Common Scale Insects.

Samples of fifteen named species are shown.

2. Scale Insects.

Twenty-eight specimens are shown, some of the samples being the same scale shown on different host plants.

3. San José Scale.

Wax models showing the life history stages of the insect, five pieces. Two additional wax models showing infested fruit of apple and pear. Infested twigs of apple and pear. Infested leaves of apple.

4. Bark Borers.

Life history series of *Scolytus rugulosus* and of *Phlœotribus liminaris*. Specimens showing characteristic work of each, and remedies and preventives for both shown on treated sticks of peach wood.

5. Shade Tree Pests.

Tussock Moth, all stages, Rosechafer, Cottonwood Leaf-beetle, Tulip Scale, etc.

6. Farm Crop Pests.

Wheat Jointworm; adults, larvæ, parasites and distorted straws.

Clover Root Borer; adults, pupæ and larvæ; specimens of injured roots pressed out by botanical driers. Chinch bugs; glued in large numbers to young corn plant, which has been pressed out by botanical driers. Vial of *Sporotrichum globuliferum* grown on corn meal and beef broth.

7 and 8. Insecticides.

Square, flat-sided bottles with curved necks are filled with insecticides and the corks are covered with red sealing wax. To illustrate the composition of sprays a vial is filled with each separate ingredient and another vial

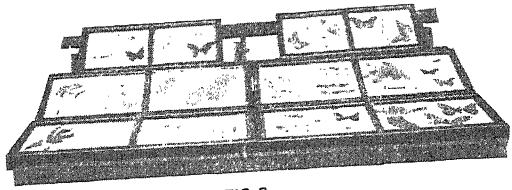


FIG. 3

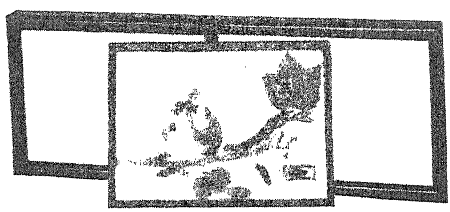


FIG. 2

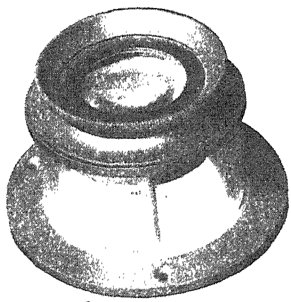


FIG. 4

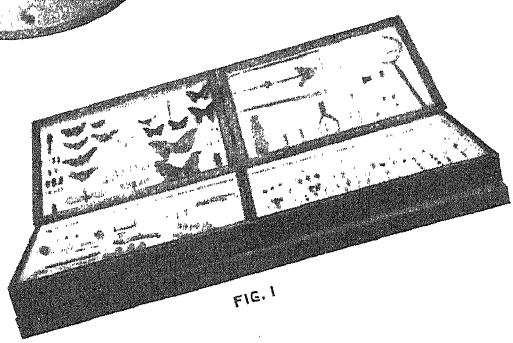


FIG. 1

1. Insect cases in position on racks; 2, Riker mount ready to fit into frame which holds a pair of mounts; 3, Riker frame in position on racks; 4, stationary magnifying glass under which small insects are shown.

holds the finished combination, the lot being grouped together. Printed directions for mixing the sprays cut from our spray calendar are pasted beneath each group of vials. Represented among these insecticides are ten poisons, one trap, four repellents, two fumigants and twelve contact insecticides. The vials are fastened in the cases by means of wires bent to fit over them and running through holes drilled in the bottom of the case. The wires are twisted together by means of pliers, and cut off on the outside. Some heavy paper and muslin serve to cover these little wire snags and thus prevent accidents.

9. Insects of the Black Locust.

Eight species and specimens of injury.

10. The Seventeen-year Cicada and different stages of the insect's life history and specimens of its injury. Also specimens of the Dog-day Cicada and examples of injury for comparison.

11. Some Beneficial Insects.

Dragon flies, lady beetles, tiger beetles, honey bees, bumble bees, lacewing flies, ground beetles, ichneumon flies, parasitic flies, etc.

12. Some Ohio Insects.

A partial type collection to illustrate the different orders and also including showy speicmens to attract attention.

13. Some Insect Galls.

Specimens of galls made by several species of insects, among them the Grape Phylloxera.

14. Some Garden Insects.

Different stages of Colorado Potato Beetle, Striped Cucumber Beetle, Radish Maggot, Flea Beetles, Squash Bug, and others, with examples of their injuries.

15. Clover Root Borer.

Different stages of its life history, and examples of injury to roots and effect on tops.

16. Grain Insects.

Hessian fly in its different stages, snapping beetles and wireworms, Meal Snout Moth in different stages and examples of injury, Chinch Bugs, May Beetles and White Grubs, with samples of injured wheat and corn plants, including roots.

17. Catalpa Midge.

Different stages of insect and examples of damaged leaves, pods and shoots.

18. Educational Case.

Methods of preserving insects. Contains spreading board with butterflies of different sizes spread on it; cyanide killing bottle, vial of insect pins, cardboard points on pins and insects mounted on points, dissecting needles, punch for making points (a worn and discarded utensil) and miniature net. Methods of pinning and mounting different orders of insects are shown.

There are six additional cases which are practically duplicates of some of the foregoing. These are used for county fairs when two exhibits are shown at different fairs on the same dates.

Case Racks

Folding racks as shown in Fig. 1, Pl. 23, are set on tables to hold the cases. Each rack will hold four cases. (See Fig. 1, Pl. 22). Poplar wood, stained black, is used for their construction.

Riker Mounts

We use two sizes of these mounts, one 8 x 12 inches, the other 6½ x 8½ inches. For inflated larvæ used in the Rikers we use an improvised "sarcophagus" or small glass tray like the one shown in the illustration, Fig. 2, Pl. 23, to prevent them from being crushed. This is made with glass slips, cut to proper size with a glass cutter and fastened at the edges and corners with strips of black passe partout or strips of lantern slide binding. The mounts are set by pairs into frames made for the purpose, as shown in Fig. 2, Pl. 22.

The framework of the frames is convex or rounded, as seen from the front, and is painted with black carriage paint and varnished. The back is exactly the same as in picture frames.

These mounts are set up on racks exactly like those used for the insect cases, except that they are somewhat smaller. Quite a common arrangement of these mounts for exhibition is shown in Fig. 3, Pl. 22.

A partial list of the mounts is as follows:

Large Mounts, 8 x 12

So far as possible the complete life series of each insect named is shown.

Frame 1 (2 mounts to each frame).
- {Velleda Lappet Moth.
- {Tobacco Worm and Moth.
- Bagworm or Basket Worm.

Frame 2.
- Fall Canker Worm.
- Elm Leaf Beetle.

Frame 3.
- Grapeberry Worm.
- Raspberry Byturus.

Frame 4.
- Winter Forms of Insect Life.
- Winter Forms of Insect Life.

Frame 5.
- Gypsy Moth.
- Brown-Tail Moth.

Frame 6.
- Texas Fever Tick.
- Cotton Boll Weevil.

Frame 7.
- Winter Forms of Insect Life.
- Question Sign Butterfly.

Frame 8.
- {Walnut Datana.
- {Apple Datana.
- Elm Leaf Beetle.

Frame 9.
- Cotton Boll Weevil.
- Spring Canker Worm.

Frame 10.
- Abbott Sphinx.
- Colorado Potato Beetle.

Frame 11.
- Cecropia Moth.
- Promethea Moth.

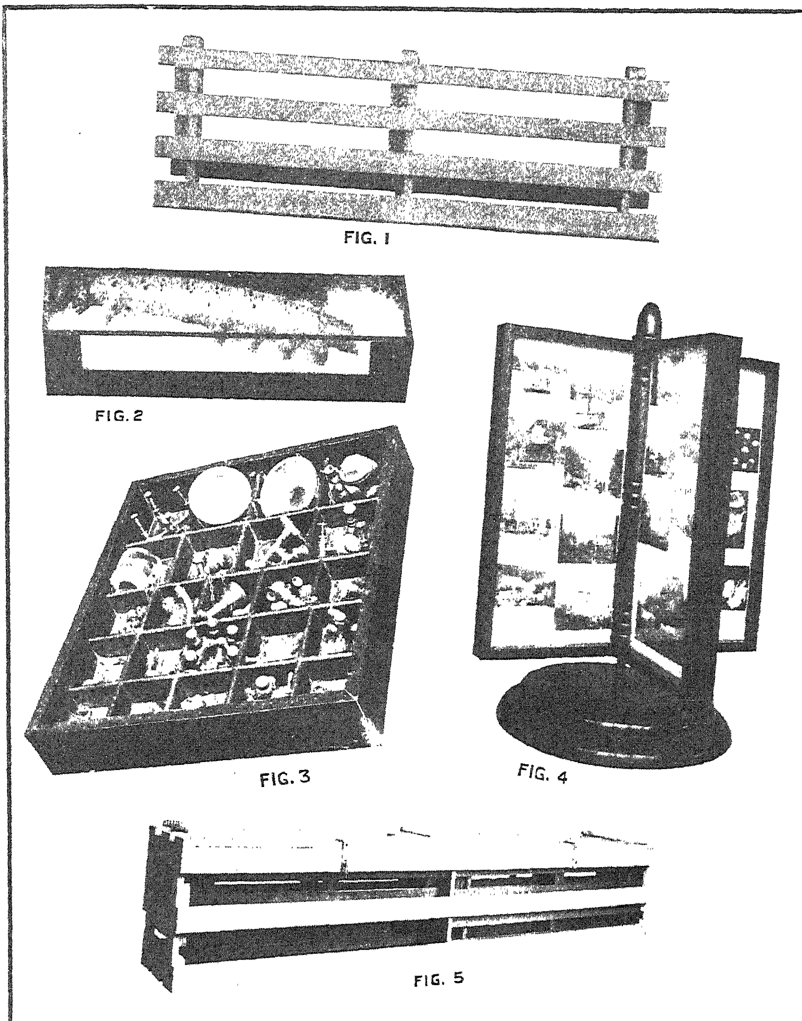
Small Riker Mounts, 6½ x 8 ½

Frame 1.
- Question-sign Butterfly.
- Imported Cabbage Butterfly.

Frame 2.
- Io Moth.
- Pipevine Swallowtail Butterfly.

Frame 3.
- Apple Datana Moth.
- Striped Cucumber Beetle.

Frame 4.
- Saddleback Caterpillar.
- Catalpa Sphinx Moth.



1. Rack for holding insect cases and Riker frames; 2, glass tray or "Sarcophagus" for holding inflated larvae in Riker mounts; 3, case of nozzles and small spraying accessories; 4, rotary stand for photographs; 5, shipping case for racks like figure 1.

Frame 5.
- Various Species of Grasshoppers with spread wings.
- Various Species of Grasshoppers with spread wings.

Frame 6.
- Duplicate of Frame 1.

Frame 7.
- Viceroy Butterfly.
- Milkweed Butterfly.

Frame 8.
- Codling Moth.
- Wax Apple with Codling Larva in burrow.
- Clover Seed Chalcid.
- Clover Leaf Weevil.

Frame 9.
- Asparagus Beetle.
- Cucumber Flea Beetle.

Frame 10.
- Virginia Tiger Moth.
- Variegated Cutworm.

Frame 11.
- Catalpa Sphinx.
- Saddleback Caterpillar.

Frame 12.
- Mourning Cloak Butterfly.
- Black Swallowtail or Celery Butterfly.

Frame 13.
- White Marked Tussock Moth.
- Fall Web Worm.

Another exhibit is a small bookcase which is labeled "Some Good Books on Entomology." Each volume is fastened to the bookcase by a brass chain so it cannot be carried off. The more important entomological publications of the Station are bound and given a place on the shelves. The publishers of the following works have contributed a copy of each to this exhibit: "Smith's Economic Entomology," "Saunders' Insects Injurious to Fruits," "Weed and Dearborn's Birds in their Relation to Man," "Comstock's Manual of Entomology," "Chittenden's Insects Injurious to Vegetables," "Sanderson's Insects Injurious to Staple Crops." A few other books were solicited for the exhibit, but the publishers failed to comprehend their opportunity and are not represented.

A case of spray nozzles, valves, stopcocks, pressure-guages, hose attachments and other small accessories of spraying outfits are shown, the pieces having been contributed by the manufacturers. A small compartment of the case is given to each company contributing, and in this are a number of small pieces which represent any superior or new devices of merit or interest made by such company. Each piece is secured to the case by a piece of brass chain of sufficient length to permit the piece being removed from the compartment and held in the hand for examination. (See Fig. 3, Pl. 23.)

There are two bundles of wheat, each containing 560 straws, all of which in one bundle are infested with Hessian fly, and all of which in the other are free from Hessian fly. The wheat is of the same variety and was all gathered from the same field during the same season. An illustration of these two bundles is found in Bulletin 177 of the Ohio Experiment Station. The two jars of wheat shown in

figure 2 of the same Bulletin are also a part of the exhibit. In one of the jars is the harvest from 4313 straws infested with Hessian fly and in the other the harvest from an equal number of straws not infested with this insect.

There is an exhibit, similar to the last mentioned, showing the harvest from wheat infested with jointworm as compared with wheat not so infested.

During the past two seasons there has been quite an exhibit of the work of the two species of bark-beetles most injurious in Ohio, viz.: *Scolytus rugulosus,* and *Phlœotribus liminaris.* Entire trees in various stages of infestation and decay have been shown, as well as breeding jars with beetles at work in various stages of development.

A device for showing small photographs of important work, spraying machines, and economic insects, is a rotary stand, modeled after those commonly used for showing illustrated postcards. There are eight faces for pictures, all of which are covered with glass. (See Fig. 4, Pl. 23.)

Large maps of Ohio are used for showing the distribution and prevalence of injurious insects in some seasons. Silk-headed tacks of different colors are used for indicating localities. Blue-headed tacks were used to indicate the localities from which wheat jointworm was reported in 1908 and on the same map red-headed tacks were used to indicate the reports received in 1909. There were several hundred of these for each of those years.

Results of entomological work on crops are also shown by the crop harvest. In the illustration of the exhibit, Plate 21, is seen a large crate of apples. Here are shown all the sound apples from a well-sprayed tree and in smaller crates beside the large one are the wormy apples from the same tree. The dropped apples from the same tree were likewise separated, the wormy from the sound. The crop from an unsprayed tree belonging to the same orchard was shown in the same way.

On either side of the pile of apples was a framed poster and map showing location of the Ben Davis trees in the Stokes orchard, which netted over $1,000 per acre in 1908. This was to show that a solid acre was used and that no selection or gerrymander was employed to find the trees for this acre.

Similar displays of grapes or other fruits are made if we happen to be working on insects which injure them.

A number of simple microscopes of the pattern shown in Fig. 4, Pl. 22, are mounted on a poplar board which is stained black, and under each is some minute insect, such as a flea or other interesting

subject, perhaps the dissected mouth-parts of a beetle or grasshopper. The microscopes are screwed to the board and the board is screwed to the table to prevent theft.

We have a considerable number of large bromide pictures. These are set in light poplar frames, painted black, no glass being used. These are used at the State Fair only. The subjects illustrated are various. Different types of spraying machinery and entomological devices are shown. Results of insecticidal practice are fully illustrated in these pictures by means of contrasted harvests, contrasted plants, vineyards, fields, etc. Three pictures are placed in each panel or frame. These pictures are placed behind the rest of the exhibit to economize space and to furnish a suitable background.

Shipping Packages

Several years' experience in handling shipping packages of all kinds and shapes has led the Coöperative Department to require that, so far as possible, boxes approximating 5 to 6 feet long, 2 feet wide and 16 to 20 inches high be used. Two or four men can handle boxes of this shape more readily than short, cubical-shaped boxes. The weight of each box after being filled should not greatly exceed 100 pounds. A strong iron handle is fastened to each end, the top is secured by strap-iron hinges at the back and by hasp and staple fastenings at the front. The hasps are secured over the staples by means of large harness snaps. At the close of each fair, a seal is applied to each box, as soon as it is filled, and this must not be broken except by a properly authorized employe of the Station.

The Entomological Department uses excelsior pillows for packing. This prevents loss of packing material and keeps cases, etc., more free from dirt and dust than would be possible if loose excelsior were used. The pillows are made of strong, cheap muslin. Each insect case, Riker mount, etc., has a muslin slip or bag into which it fits for protection against dirt and dust. Compartments are made in the long boxes for such articles as the nozzle-case, the book-case, etc. Some pieces, such as maps and the rotary photograph stand have cases specially built for them, since they would not readily be accommodated in the long boxes.

Since the inventory of the Entomological Department comes second in order in the records of the Coöperative Department, all boxes of our Department are marked O. A. E. S. 2. They are then marked Entomology 1, 2, 3, 4, etc., until every package has received a number. Any article which is meant to be packed in the box marked Entomology 4, for instance, is marked Entomology 4 (see Fig. 5, Pl.

23[1]), and thus the work of packing is expedited and the chances for loss greatly minimized. A complete list of all the articles which belong in each box is tacked on the inside of the cover or kept in possession of a designated person for ready reference.

RECENT OBSERVATIONS UPON EUROPEAN INSECTS IN AMERICA

By E. P. Felt, *Albany, N. Y.*

The occurrence of large numbers of brown tail moth nests upon seedlings imported last winter and the year before has greatly stimulated interest on the eastern coast, in the possibility of introducing pests with the importation of nursery stock. The thorough inspection for brown tail moth nests has resulted in finding a number of other insects. The introduction of the pine blister rust has also tended toward more thorough inspection. It is proposed in this brief account to notice a few pests which have been brought to attention during the last few months, and it is hoped that this paper will be but one of a series discussing briefly, insects which have been detected on importations of nursery stock or giving accounts of other forms likely to be brought into the country in this manner. We would welcome in this connection the coöperation of specialists, since they are best qualified to indicate the more dangerous species and to point out the best method of detecting them in shipments of stock.

Pissodes notatus Fabr. Seedling pines shipped from Oudenbosch, Holland, and submitted for examination by the State Department of Agriculture, had the stems infested by full grown larvæ which shortly pupated. Adults of the above species were reared in early May. This European species, kindly identified by Dr. A. D. Hopkins of the U. S. Bureau of Entomology, is about one third larger than our native *Pissodes strobi* Peck, and is most easily separated therefrom by the indistinct ocherous red coloration and the smaller, more inconspicuous, whitish spots on the distal third of the wing covers. Doctor Hopkins states that this is a very important enemy of the pine in Europe and that owing to the danger of its becoming a serious pest in this country, every precaution should be adopted to prevent its obtaining a foothold in America. It would certainly

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[1] The illustrations for this article were prepared by Messrs. W. H. Goodwin and W. P. Beeching of the Ohio Station.

be much safer to exclude seedling pines, particularly as there is grave danger of importing the very destructive pine blister rust.

Dichromeris marginellus Fabr. The European juniper webworm, kindly identified through the courtesy of Doctor Howard and Mr. Busck, discussed below, appears to have become well established in New York State, since abundant material was received in February last from Mr. S. G. Harris, Tarrytown, N. Y., and later through the State Department of Agriculture from L. D. Rhind of Plandome, L. I. The light brown larvæ some 6 mm. long were observed upon the junipers in early March. They form an irregular web and appear to live to a large extent, at least, upon the dead or nearly dried juniper needles. At least a number of moths were reared the last of May and in early June from nearly dried juniper twigs collected the preceding March. This alone suggests that the larvæ can thrive to a considerable extent upon rather dry vegetable matter.

Larva. Length 6 mm. Head dark reddish brown, sparsely clothed with setæ. Antennæ yellowish brown, short; thoracic shield broad, a variable dark brown, setose. Segments distinct. Body light brown, longitudinally striped as follows: Median stripe reddish brown, submedian stripes whitish, sublateral stripes dark brown, the lateral light reddish brown; all somewhat broken. Body setæ with a length about half the diameter of the body, light brown; tubercles small, brown. Thoracic legs dark brown, prolegs yellowish white, light brown apically. Ventral plate reddish brown, the middle paler, the posterior margin dark brown, sparsely setose.

Adult. Length 7 mm. Wing spread 15 mm. This beautiful moth is most easily recognized by the reddish brown forewings bordered anteriorly and posteriorly with a broad, silvery stripe, the latter tapering slightly and disappearing near the tip of the wing. The rather long palps are reddish basally, grayish distally, creamy white dorsally and near the middle with a slender pencil nearly as long as the palpi, extending dorsally. The head and the anterior portion of the thorax mesially, is thickly clothed with long, creamy white scales.

Hyponomeuta malinella Zell. Apple seedlings with the web nests of the above named species were found during June by agents of the State Department of Agriculture, on blocks of recently imported trees here and there in the state. This species and more especially the allied *H. padella* Linn. were noticed earlier in some detail by Professor Parrott[1] and the record given below is of interest largely since it records the continued introduction of members of this genus.

[1] 1910, Parrott, P. J. Econ. Ent. Journ., 3: 157–61.

Eggs, according to Professor Parrott, are deposited during July on small twigs, in oval patches about 4 or 5 mm. in diameter. Hatching occurs in early autumn and the tiny caterpillars remain sheltered through the winter under the protecting egg mass. It is consequently much easier to find the nearly full grown caterpillars in June than to detect the rather inconspicuous egg masses and the hidden caterpillars at the time nursery stock is usually imported. The ermine moths are considered abroad as very destructive fruit tree pests and are forms which should be excluded from this country.

Saturnia pavonia Linn. One specimen of the dark reddish brown cocoon of this Bombycid was found on nursery stock at Rochester, N. Y. The cocoon is 3.5 cm. in length, 2.5 cm. in diameter and with one end somewhat produced and partially open. The moth has a wing spread of 7.5 cm., is smaller than our well known *Calosamia promethea* Drury, and the coloring is mostly in shades of gray with distinct ocellate spots on both the anterior and posterior wings. There should be no difficulty in excluding this rather large species.

Monarthropalpus buxi Lab. This European box leaf midge was found by Prof. A. E. Stene in May, 1910, infesting a box hedge, *Buxus sempervirens*, at Kingston, R. I. Galls received May 25 produced an abundance of midges, the insects completing their transformations in the galls and on emerging left their whitish exuviæ protruding. It would not be surprising were this European species to be found in other parts of the country. The insect undoubtedly became established in this country by the importation of infested box trees.

Gall. This is a more or less irregular, oval swelling of the leaf, with an eccentric, oval, clear space excavated by the yellowish larvæ. There is a very slight elevation of the leaf with an irregular, yellowish or brownish discoloration, the margin of the enlargement being indicated by a darker green. The gall is most easily seen by transmitted light.

Adult. The rather large, yellowish orange midges have a length of 2 to 2.5 mm. in the male and female, respectively. Antennal segments 14, the flagellate binodose in the male; the female having the fifth with a stem about one half the length of the cylindric basal enlargement. These midges are easily separated from Hormomyia by the mesonotum not projecting over the head, and from their other allies by the uniarticulate palpi.

Detailed descriptions will be published in the authors' monograph on this group.

Chermes piceæ Ratz. Nordmann's firs received from Europe and

submitted for examination by the State Department of Agriculture, were found infested by a Chermes which was provisionally determined as the above named species by both Dr. A. D. Hopkins of the U. S. Bureau of Entomology and the writer. This appears to be the first record of the introduction of this insect into America. It has been recorded by Gillanders as very destructive to young silver firs, comparatively young specimens of *Abies nordmanniana* and even fairly old trees of *Abies nobilis*. He states that young silver firs in nurseries are often killed outright by this insect. The data at hand justifies us in considering this species a dangerous form which should be excluded if possible.

SOME RESULTS FROM FEEDING EGGS OF PORTHETRIA DISPAR TO BIRDS[1]

By C. W. COLLINS, *U. S. Dep't. of Agriculture, Bureau of Entomology, Melrose Highlands, Mass.*

The question is ofttimes asked, "Do birds eat the eggs of the gipsy moth?" Several years ago Mr. E. H. Forbush stated that "No bird has actually been proved to feed upon the eggs except the English sparrow. One of these birds which was kept in confinement ate a few of the eggs from time to time when deprived of other food, but did not appear to relish them."[2] There is a possibility that some species may eat the eggs when other food becomes scarce. The latter often happens during the winter when *Porthetria dispar* eggs are found on trees, fences, stonewalls and in various other places for ten months of the year and may offer some temptation to birds at such critical times. The agents and inspectors engaged in gipsy moth work frequently report having seen egg clusters which have apparently been broken by birds.

At the suggestion of Mr. W. F. Fiske some experiments in feeding birds were conducted. Some English sparrows and a pigeon were secured. One of the purposes of the investigation was to determine the condition and vitality of the eggs after having passed through the digestive tract. The sparrow was chosen for the experiment mainly because it had been known to feed upon the eggs in confinement; the pigeon, merely to determine if the eggs would be digested. In all cases it was necessary to force the birds to eat them.

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[1] Occasional contributions from the Gipsy Moth Parasite Laboratory, V.

[2] Mass. Board of Agriculture. "The Gypsy Moth." 1896, p. 231.

Experiment in Feeding English Sparrows

The first lot of six sparrows was caught February 20. These were not offered food unfortunately until the following day, as the cage described later was being constructed. The hairy covering of the egg-cluster was removed by gently rubbing over cheesecloth, stretched between two boards. The eggs were mixed with dough made of corn-meal and water and used for food. The last of this lot of birds died during the night of February 21.

This proved an unsuccessful way of obliging the birds to eat the eggs. After a bolus of the food was forced into the beak, and the latter released in order that the bird might swallow, it would move the tongue to and fro, ejecting most of the eggs. No parts of eggs were found in the excrement or gizzard after the bird's death. This showed that none were swallowed by them while in captivity. Similar results were obtained from the second lot, which were captured March 6, and which died on the evening of March 7.

A different method was pursued in the latter experiments to compel the sparrows to swallow the eggs. They were inserted by means of a dampened toothpick, to which the eggs adhered. The toothpick was inserted well into the mouth and sometimes conveyed ten to fifteen of these, after which the sparrow was given a swallow of water. In this manner the birds were forced to swallow several eggs as is shown by the table.

One bird was captured March 27 and died March 29; the other two April 10 and died April 11 and 12, respectively. In these experiments half-pound candy boxes were used, while the first two lots of birds were kept in a cage. It measured 8 inches square by 12 inches deep, with fly screen top and bottom. In one side a hole, large enough to admit the hand, was made and provided with a slide cover. By this arrangement it was possible to remove them conveniently at feeding time. It was decided that this cage was too large and allowed the birds too much freedom to fly, so that they killed themselves by constantly beating against the screens. The small candy boxes proved more satisfactory.

Approximately 356 *P. dispar* eggs were fed to the last three sparrows. One hundred and forty-two of these eggs or 40 per cent. were found intact in the excrement. Seven of the 356 (2 per cent.) or 5 per cent. of the 142 that were passed intact hatched. One hundred and thirty-five or 38 per cent. was the approximate number found to be digested or partly so. Small pieces of chorion, which is indigestible, could usually be seen with the aid of a lens. Seventy-nine of the

TABLE SHOWING NUMBER OF *PORTHETRIA DISPAR* EGGS EATEN, DIGESTED, PASSED INTACT AND HATCHED

No. of birds.	Date captured.	Fed Gipsy Moth eggs.	Approximate number of eggs fed.	Excrement removed.	No. of eggs intact in excrement.	Approximate number of eggs digested in excrement.	No. of eggs hatched in excrement.	Birds died.	No. of eggs intact in gizzard.	No. of eggs digested in gizzard.
				English Sparrow						
6	Feb. 20	Feb. 21, 2 p. m.						4—Feb. 21	0	
								2—Feb. 22	0	
3	Mar. 6	Mar. 7, 6 p. m.		Mar. 8	0	0	0	Mar. 8		
1	Mar. 27	Mar. 27, 9 p. m.	13	Mar. 28, 7.30 a. m.	5	7	1			
		Mar. 28, 7.30 a. m.	7	Mar. 28, 12.30 p. m.	1	6	0			
		Mar. 28, 12.30 p. m.	8	Mar. 28, 6 p. m.	0	8	0			
		Mar. 28, 6 p. m.	21	Mar. 29, 8 a. m.	2	9	1			
		Mar. 29, 8 a. m.	17					Mar. 29, 10 a. m.	8	20
1	Apr. 10	Apr. 10, 8 p. m.	30	Apr. 11, 9 a. m.	7	23	0			
		Apr. 11, 9 a. m.	73	Apr. 11, 11.30 a. m.	36	37	0			
		Apr. 11, 11.30 a. m.	46					Apr. 11, 4.30 p. m.	4	42
1	Apr. 10	Apr. 10, 8 p. m.	7	Apr. 11, 9 a. m.	2	5	1			
		Apr. 11, 9 a. m.	75	Apr. 11, 11.30 a. m.	70	5	3			
		Apr. 11, 11.30 a. m.	59							
		Apr. 11, 4.30 p. m.	Cracked corn	Apr. 12, 9 a. m.	19	35	1	Apr. 12, 9 a. m.	0	5
		Totals	356		142	135	7		12	67
				Pigeon						
1	Feb. 26	Feb. 26, 6 p. m.	Cracked corn					Killed		
		Feb. 27, 11.20 a. m.	200	Feb. 27, 11.20 a. m.	0					
				Feb. 27, 2.10 p. m.	0	100—?				
		Feb. 27, 8 p. m.	200	Feb. 27, 8 p. m.	0	100—?				
		Feb. 28, 8.10 a. m.	200	Feb. 28, 12.30 p. m.	0	145—?				
		Feb. 28, 10 p. m.	200	Feb. 28, 10 p. m.	0	175—?				
				Mar. 1, 4 p. m.	0	75—?				
		Mar. 1, 6 p. m.	200							
		Mar. 2, 8.15 a. m.	200	Mar 2, 8.15 a m.	0	50—?		Mar. 2, 6 p. m.	178	22
		Totals	1,200		0	645—?			178	22

eggs or 22 per cent. still remained in the gizzard of the three sparrows after death. Twelve of these were intact, while the remainder consisted of various sized pieces of chorion.

Many of the eggs that were found whole in the excrement contained large wrinkles. This was undoubtedly the result of the grinding and pressure the eggs received while passing through the gizzard. This organ is very muscular and by its contraction and expansion, assisted by the gastric juices, has a tendency to crush all contents. Undoubtedly most of the 135 eggs passed intact, which did not hatch, were injured in passing through this organ.

Experiment in Feeding a Pigeon

A female pigeon was secured February 26 and encaged in a box 12 x 12 x 18 inches. Cracked corn and dough containing *P. dispar* eggs were placed in the cage during the first day, but the pigeon did not partake of either. It appeared very lonely and inactive, which was perhaps due to being separated from its mate. As it did not take food voluntarily, it was removed from the cage twice daily, and egg and dough mixture forced into the beak. About 200 eggs were given each time. The excrement was removed from the cage after each voidance, and carefully examined, yet it revealed no eggs intact. They were well ground in every case, leaving no parts distinguishable, save the small particles of chorion. The pigeon was fed for the last time at 8.15 a. m., March 2, and killed at 6 p. m. of the same day. No excrement was found in the cage after the morning feeding. Three hundred and fifty-five eggs intact and some meal were found in the crop. One hundred and seventy-eight and fragments of 22 others were removed from the gizzard. This indicates the slowness and thoroughness with which the pigeon digests its food. The vitality of gypsy moth eggs is totally destroyed after having been subjected to such a grinding process.

In concluding, it must be borne in mind that these experiments were conducted under abnormal conditions. The birds were not only forced to swallow the food, but were deprived of their freedom, which is essential to rapid and vigorous digestion. To procure the data obtained would have been difficult in the field, as it would have necessitated long and careful watches and the killing of many useful species. It would have been impossible to find the voided excrements desirable. However, there remains a field open to investigation for accurate notes on species of birds liable to eat the eggs of *P. dispar,* and the condition of the latter when recovered in the excrement under normal conditions.

GALL MIDGES OF ASTER, CARYA, QUERCUS AND SALIX

By E. P. Felt, *Albany, N. Y.*

The following tabulation of the species reared from the above named plants will prove of service in identifying the midges occurring thereupon. It is extremely interesting to compare the 18 species occurring upon aster with the 35[1] found living at the expense of solidago. It is probable that these lists represent conditions with a fair degree of accuracy, since the data in both instances has been obtained very largely by collections on asters and solidagos in the vicinity of Albany, N. Y., and also at Magnolia, Mass. The tabulation of hickory species shows that many of the midge galls occurring upon this plant are produced by Caryomyia, a peculiar and extremely interesting genus which appears to be restricted to this food plant. The same is true in large measure of Quercus and Cincticornia, this latter Cecidomyiid genus probably being confined to the oaks.

The willow, with its dominance in certain localities and numerous species, is also extremely interesting, since it affords sustenance to about 46 species of gall midges, some 5 living upon the leaves, 13 producing bud galls of various kinds, which, in turn, are inhabited by 7 other species, mostly inquilines. There are, in addition, 21 species infesting the twigs, a number of these occurring in the slender, very slightly enlarged twigs and hardly producing a gall. A few excavate galleries in the wood, while the majority work in the subcortical tissues. The willow is a marked favorite with Rhabdophaga, members of this genus producing conspicuous bud and twig galls. Several species of Mayetiola are also found and in one instance at least species belonging to two genera were reared from the same twig.

Aster

Flower or Bud Galls

Aborted head on *Aster patens*. Adult, length 4 to 5 mm., dark brown, easily recognized by the broadly, white-banded tarsi.

Asphondylia monacha O. S.

Dwarfed or stunted flower heads on *Aster paniculata*. Female, length, 2.5 mm., reddish brown; 19 antennal segments, the fifth with

[1] 1909, Felt, E. P. Gall Midges of the Goldenrod, Ottawa Naturalist, 22: 245–49.

a stem one fifth the length of the cylindric basal enlargement, which latter has a length 2½ times its diameter.

Rhopalomyia asteriflorae Felt.

Axillary bud galls on *Aster lateriflorus*, diameter 10 mm. Male, length 1.5 mm., fuscous yellowish; 18 antennal segments, the fifth with a stem as long as the basal enlargement, which latter has a length one half greater than its diameter. Female, length 3 mm., reddish orange; 20 antennal segments, the fifth with a stem one fifth the length of the basal enlargement.

Rhopalomyia lateriflori Felt.

Leaf Galls

Blister galls

Gall yellowish white, nearly circular, 2 to 3 mm. in diameter; on *Aster macrophyllus*. Male, length 2 mm., abdomen dark brown, the segments narrowly white banded; antennal segments 15, the fifth with a length one quarter greater than its diameter, palpi triarticulate. Female, length 1.5 mm., abdomen dark brown; 18 antennal segments, the fifth with a length slightly greater than its diameter.....................*Lasioptera clarkei* Felt.

Gall yellowish brown, narrowly oval, length 4 mm., diameter 2 mm. Female, length 1.75 mm., abdomen dark brown, the segments narrowly white margined; antennal segments 13, the fifth with a length one third greater than its diameter, palpi uniarticulate.............................*Asteromyia*[1] *dumosae* Felt.

Gall brownish, yellow ringed, circular, diameter 3 mm. Male, length 2 mm., abdomen dark brown, the segments narrowly margined; antennal segments 16, the fifth with a length three quarters its diameter, palpi biarticulate. Female, length 2.25 mm.; antennal segments 18.......................*Asteromyia waldorfi* Felt.

Gall yellowish, shining, oval, diameter 6 to 7 mm. Female, length 2 mm., abdomen dark brown, the segments narrowly white margined; antennal segments 22, the fifth with a length three quarters its diameter, palpi biarticulate..*Asteromyia nitida* Felt.

Gall pinkish, large, oval blotches on *Aster divaricata*, diameter 10 to 12 mm. Male, length 2 mm., abdomen dark brown, the basal segment sparsely white margined laterally and posteriorly; antennal segments 16, the fifth with a length twice its diameter, palpi uniarticulate. Female, length 2 mm., abdomen dark brown, the segments with submedian white spots; antennal segments 16.

Asteromyia divaricata Felt.

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[1] Asteromyia n. g. This new genus is erected for certain American species previously supposed to be referable to Baldratia Kieff. Type *Lasioptera carbonifera* Felt.

Gall yellowish or brownish, irregularly oval, diameter 3 mm. Female, length 2 mm., abdomen dark pulplish brown, the first and second segments margined with reddish orange, the third to fifth broadly margined sublaterally with silvery white; antennal segments 17, the fifth with a length a little greater than its diameter ....*Asteromyia marginata* Felt.

Gall yellowish or brownish, irregularly oval, diameter 6 mm.; on *Aster paniculata*. Male, length 2 mm., abdomen dark purplish brown; antennal segments 14, the fifth with a length one half greater than its diameter, palpi uniarticulate.
Asteromyia paniculata Felt.

Gall greenish yellow or papery white, diameter 1.75 cm.; on *Aster lævis*. Male, length 1.6 mm., abdomen dark brown; antennal segments 14, the fifth with a diameter about equal to its length, palpi uniarticulate...................*Asteromyia læviana* Felt.

Gall sooty yellow beneath, dirty white above, length 2 cm., diameter 1.2 cm. Female, length 2 mm., abdomen black, the segments with submedian white spots; antennal segments 16, the fifth with a length hardly equal to its diameter, palpi uniarticulate.
Asteromyia flavomaculata Felt.

Gall yellowish white, dark margined, diameter 3 mm. Female, length 2 mm., abdomen black, the segments sparsely white margined; antennal segments 18, the fifth with a length three quarters its diameter, palpi biarticulate.
Asteromyia asterifolia Beutm.

Gall, oval, green swellings, length 2 mm., diameter 1.5 mm. Male, length 1.75 mm., abdomen mostly dark brown; antennal segments 14. Female, length 2 mm., abdomen dark brown, the segments with lunate, submedian white spots; antennal segments 15, the fifth with a length one third greater than its diameter, palpi uniarticulate.................*Asteromyia vesiculosa* Felt.

Stem or Branch Galls

Gall a small, pustulate swelling on aster stems, diameter 3 mm. Male, length 2 mm., abdomen dark brown, the segments with submedian, lunate, white spots; antennal segments 14, the fifth with a length a little greater than its diameter, palpi uniarticulate.
Asteromyia pustulata Felt.

Fusiform stem or branch gall, length 1 cm., diameter .4 cm. Male, length 2.75 mm., abdomen dark brown, the segments with submedian, white spots; antennal segments 19, the fifth with a length greater than its diameter. Female, length 2.75 mm., abdomen dark

brown or black with submedian, white spots; antennal segments 21, the fifth with a length hardly equal its diameter.

Neolasioptera ramuscula Beutm.

Greenish brown, fusiform, irregular stem swelling at or near the base of the leaf, length 1 cm., diameter .6 cm., on *Aster infirmus*. Male, length 2.5 mm., abdomen dark brown; antennal segments 20, the fifth with a length hardly equal its diameter. Female, length 3 mm., abdomen dark brown with submedian, lunate, white spots; antennal segments 24 or 25, the fifth with a length three quarters its diameter........................*Neolasioptera albitarsis* Felt.

Oval twig gall on *Aster novæ-angliæ*. Male, length 2.5 mm., abdomen reddish brown, the segments margined with long hairs; antennal segments 18, the fifth with a stem three quarters the length of the basal enlargement, which latter has a length 2½ times its diameter, palpi uniarticulate................*Rhopalomyia astericaulis* Felt.

Ovate, sessile, brownish galls densely white haired, length 7 mm., on *Aster crassulus*. Male, length 1.5 mm., abdomen dark brown basally, lighter distally; 18 antennal segments, the fifth with a stem three quarters the length of the basal enlargement, which latter has a length nearly twice its diameter, palpi biarticulate.

Rhopalomyia crassulina Ckll.

Carya (Hickory)

Leaf Galls

Cylindric galls.

Greenish or black, 4 to 5 mm. long, 1 mm. in diameter.

Caryomyia tubicola O. S.

Conical galls.

Base subglobular with a long, slender apical process, greenish to reddish brown, 3 to 4 mm. long. Occurs in groups on midrib of bitternut hickory..................*Caryomyia caryæcola* O. S.[1]

Conical, nearly symmetrical, thin-walled, small, green or red tinted, length 2 mm...................*Caryomyia sanguinolenta* O. S.

Globose galls.

Smooth or nearly so.

Nearly smooth, thin-walled yellowish green or brown, sparsely haired, usually with a slight nipple, diameter 2 mm.

Caryomyia caryæ O. S.

Thin-walled, depressed, yellowish green or brown, diameter 2 to 2.5 mm.........................*Caryomyia consobrina* Felt.

[1] *Schizomyia caryæcola* Felt was supposed to have been reared from this gall. The one or two specimens obtained were probably accidental.

Thin-walled, probably similar to the above.
Caryomyia arcuaria Felt.
Thin-walled without the nipple of *Caryomyia caryæ*, with a yellowish pubescence, diameter 2 to 4 mm.. *Caryomia similis* Felt.
Thick-walled, yellowish green or brown, diameter 4 to 5 mm.
Caryomyia antennata Felt.
Thin-walled with a false chamber at the apex, diameter 2 to 3 mm.
Caryomyia inanis Felt.

Hairy.
Thick-walled, brown or reddish brown, hairs rather short, curly, diameter 6 to 7 mm. .... *Caryomyia persicoides* Beutm.
Similar to the above and other Caryomyia galls,[1] probably inquiline .... *Clinodiplosis caryæ* Felt.
Thin-walled, rust red, hairs long, straight, diameter 2 to 4 mm.
Caryomyia holotricha O. S.
Gall similar to the above, the midge probably inquiline.
Mycodiplosis holotricha Felt.
Thin-walled, long haired, melon-shaped, diameter 2 to 3 mm.
Caryomyia thompsoni Felt.

Midrib gall.
A rounded, irregular, pale yellowish, hard swelling 12 mm. long.
Caryomyia cynipsea O. S.

Forming no gall.
An irregular, yellowish brown margined elevation, diameter 3 mm. Larva attached by a viscid secretion.. *Caryomyia*[2] *glutinosa* O. S.

Swellings in Husks

Irregular swelling in the husks produced by pale reddish larvæ.
Caryomyia[2] *nucicola* O. S.

Quercus (Oak)

Fruit

Reared from larvæ found between the seed coats of an acorn. Female, length 1 mm., abdomen yellowish brown; antennal segments 14, the fifth with a length about 2½ times its diameter.
Dasyneura glandis Felt.

Flower Galls

Reared from undescribed galls on blossoms of oak. Female, length 1.5 mm., abdomen reddish brown, the basal segment white, the

[1] This species was apparently reared from the gall of *Caryomyia inanis* and that of *C. persicoides*.

[2] The reference of this larva to Caryomyia is provisional only.

others with submedian, white spots; antennal segments 33, the fifth with a length three quarters its diameter.
Lasioptera querciflora Felt.

Leaf Galls

Leaf edge galls.

Gall a folded leaf edge between serrations. Female, length 1.5 mm., abdomen deep red; antennal segments 14, the fifth with a length 2½ times its diameter... *Cecidomyia foliora* Rssl. & Hkr.

Similar gall, possibly identical........ *Cecidomyia erubescens* O. S.

Vein galls.

A narrow, dark purplish, fusiform, thin-walled swelling on the under side of the mid or lateral veins may contain two or more orange larvæ, length 8 mm. Male, length 2 mm., abdomen reddish or dark brown; antennal segments 14, the fifth with a length nearly four times its diameter. Female, length 2.5 mm., abdomen dark brown, the fifth with a length four times its diameter.
Cincticornia podagræ Felt.

Gall very similar to, if not identical with the above.
Cincticornia majalis O. S.

Elongate, pocket-like swellings along midrib of round-leaved scrub oak. Male, length 1 mm., abdomen yellowish brown; 14 antennal segments, the fifth having the basal portion of the stem with a length one half greater than its diameter, the distal part with a length twice its diameter............ *Clinodiplosis florida* Felt.

An elongate fold gall close to the midrib on the under surface, length 12 mm., diameter 1 mm.; on *Quercus tinctoria*.
Cecidomyia q-oruca Walsh.

A large midrib fold with a conspicuous white pubescence.
Cecidomyia niveipila O. S.

Globose or subglobose, thickened, usually reddish, galls.

Reddish, oval, irregular, wrinkled leaf gall, diameter 3 to 4 mm. Male, length 3 mm., abdomen dark brown; antennal segments 14. Female, length 3.5 mm., abdomen dark red; antennal segments 14, the fifth with a length about 2½ times its diameter.
Cincticornia pilulæ Walsh.

A similar gall, apparently Southern, possibly made by the same species......................... *Cincticornia symmetrica* O. S.

Gall similar to though much smaller than that of *Cinciticornia pilulæ*. Female, length 1.25 mm., abdomen a nearly uniform dark reddish brown; antennal segments 18, the fifth with a length a little greater than its diameter.......... *Dasyneura florida* Felt.

Reared from oak, presumably from a gall resembling that made by

Cynips. Male, length 1 mm., abdomen light yellowish with a dark fuscous spot dorsally on the third and fourth segments; antennal segments 14, the fifth having the basal portion of the stem with a length about four times its diameter, the distal part with a length five times its diameter.

Thecodiplosis quercifolia Felt.

A subhemispheric, brown, slightly nippled, monothalamous gall on the under side of the leaf, diameter 1.75 mm. Male, length 2 mm., abdomen dark brown; 14 antennal segments, the fifth with a length about three times its diameter. Female, length 2 mm., abdomen reddish orange, the fifth antennal segment with a length fully 4 times its diameter....*Cincticornia globosa* Felt.

Flat, inconspicuous galls.

A flat, relatively inconspicuous, probably blister gall. Male, length 1.5 mm., abdomen dark reddish brown; 14 antennal segments, the third with a length about twice its diameter. Female, length 1.5 mm., abdomen reddish brown, the third antennal segment with a length twice its diameter..*Cincticornia quercifolia* Felt.

A slight circular, blister-like swelling on the lateral veins, length 3 mm., diameter 1 mm. Male, length 2.5 mm., abdomen mostly yellowish orange; antennal segments 14, the fifth with a length three times its diameter. Female, length 2 mm., abdomen with the sclerites dark brown, the membrane and pleuræ deep orange, the fifth antennal segment with a length 2½ times its diameter.

Cincticornia americana Felt.

A broadly, yellow margined, circular, blister gall, diameter 3 mm. Male, length 2 mm., abdomen dark brown; antennal segments 14, the fifth with a length about 4 times its diameter.

Cincticornia serrata Felt.

A variable brown, irregularly oval, pustulate swelling 5 to 6 mm. in diameter. Male, length 2 mm., abdomen deep reddish orange; 14 antennal segments, the fifth with a length about three times its diameter. Female, length 2 mm., abdomen dark brown, the fifth antennal segment with a length four times its diameter.

Cincticornia pustulata Felt.

An irregularly oval, pustulate swelling 5 to 6 mm. in diameter showing equally on both surfaces but with no nipple. Male, length 2 mm., abdomen dark brown; 14 antennal segments, the fifth with a stem one quarter the length of the basal enlargement, which latter has a length 2½ times its diameter. Female, length 2 mm., abdomen dark brown, the fifth antennal segment with a length 3½ times its diameter........*Cincticornia simpla* Felt.

Probably reared from oak leaves. Male, length 1.5 mm., abdomen reddish brown, the segments thickly margined posteriorly with brown setæ: antennal segments 14, binodose, the basal portion of the stem very short, the distal part with a length one half its diameter.....................*Dicrodiplosis quercina* Felt.

Twig Galls

Reared from twigs of white oak, *Quercus alba*. Female, length .75 mm., abdomen dark brown, the first segment dorsally silvery white, the second to fourth with submedian white spots; antennal segments 28, the fifth with a length about three quarters its diameter. *Lasioptera querciperda* Felt.

Salix (Willow)

Leaf Galls

Fusiform pod or curled leaves, length 10 mm. *Dasyneura salicifolia* Felt.

Closely rolled terminal leaves............*Rhabdophaga plicata* Felt.

Yellowish, red spotted, flattened gall, diameter 2 to 3 mm. *Oligotrophus salicifolius* n. sp.[1]

Subconic, truncate, greenish yellow, lipped gall, diameter 2 mm. *Hormomyia verruca* Walsh.

Apparently reared from same gall........*Clinorhyncha filicis* Felt.

Bud Galls

Spongy or clustered rosette gall............*Mayetiola walshii* Felt.

Small, rosette gall, length 2 cm............*Rhabdophaga racemi* Felt.

Oval, small, rosette gall resembling a small *R. brassicoides* gall. *Rhabdophaga normaniana* Felt.

Large, loose, rosette gall, length 1 to 2 cm. *Rhabdophaga rhodoides* Walsh.

Large, open, rosette, or cabbage, gall, diameter 1 to 2 cm. *Rhabdophaga brassicoides* Walsh.

Reared from above gall.................*Dasyneura orbitalis* Walsh.

Reared from above gall........*Lestodiplosis septemmaculata* Walsh.

Reared from above gall..................*Rhopalomyia frater* Ckll.

Pine-cone gall, length 2 to 2.5 cm...*Rhabdophaga strobiloides* Walsh.

Reared from above gall...............*Dasyneura annulipes* Walsh.

[1] Male: Length 2 mm., antennal segments 14, the fifth with a stem as long as the basal enlargement, which latter has a length twice its diameter. Mesonotum dark reddish, postscutellum fuscous. Scutellum and abdomen reddish yellow. Legs fuscous straw. Female: Length 2.25 mm., the fifth antennal segment with a length 2½ times its diameter. Abdomen deep red.

Reared from above gall................*Dasyneura atricornis* Walsh.
Reared from above gall..............*Cecidomyia atrocularis* Walsh.
Reared from above gall...............*Dasyneura albovittata* Walsh.
Reared from above gall.........*Lestodiplosis decemmaculata* Walsh.
Pine-cone gall resembling a slender *R. strobiloides* gall.
Rhabdophaga persimilis Felt.
Ovate, terminal bud gall, diameter 1 cm.
Rhabdophaga gnaphaloides Walsh.
Small bud gall........................*Dasyneura californica* Felt.
Small bud gall.........................*Rhabdophaga gemmæ* Felt.
Reared from apparently normal bud....*Rhabdophaga latebrosa* Felt.
Small, conic, apical bud gall...............*Dasyneura gemmæ* Felt.

Twig Galls

Reared from willow twigs, gall undescribed.
Asphondylia salictaria Felt.
Larvæ in subcortical cells, no swelling....*Dasyneura corticis* n. sp.[1]
Slender twigs, slightly enlarged.........*Sackenomyia packardi* Felt.
Slender twigs, slightly enlarged..........*Sackenomyia porteræ* Ckll.
Slender twigs, slightly enlarged............*Mayetiola caulicola* Felt.
Slender twigs, slightly enlarged........*Rhabdophaga caulicola* Felt.
Twigs probably hardly enlarged..........*Mayetiola perocculta* Ckll.
Slender twigs, slightly enlarged..........*Mayetiola americana* Felt.
Twigs uniformly enlarged, gall 5 to 7 cm. long.
Rhabdophaga podagræ Felt.
Gall similar to above, cells in wood.....*Rhabdophaga cornuta* Walsh.
Twigs irregularly enlarged, galls 1 to 3 cm. long.
Rhabdophaga salicis Schr.
Twigs irregularly enlarged, gall 1 to 3 cm. long, buds dwarfed.
Rhabdophaga triticoides Walsh.
Apical, fusiform, beaked gall, length 2 cm....*Mayetiola rigidæ* O. S.
Reared from similar gall..............*Rhabdophaga sodalitatis* Felt.
Nodular gall at base of twig, length 8 mm.
Rhabdophaga nodulosa Walsh.
Inconspicuous knot or twig enlargements..*Mayetiola latipennis* Felt.

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[1] Male: Length 2 mm., antennal segments 16, the fifth with a stem three fourths the length of the cylindric basal enlargement, which latter has a length twice its diameter. Mesonotum dull black. Scutellum fuscous yellowish, postscutellum a little darker. Abdomen dull reddish orange. Legs a variable fuscous yellowish. Female: Length 1.75 mm., 15 antennal segments, the fifth with a length 2½ times its diameter. Mesonotum dull brown. Abdomen deep red.

Subglobular, lateral gall with dead area on one side, diameter 9 mm. *Rhabdophaga globosa* Felt.
Irregular, ovoid or subglobular galls, diameter 1 to 2 cm. *Rhabdophaga batatas* Walsh.
Same gall as above.................. *Rhabdophaga ramuscula* Felt.
Same gall dried........................ *Asynapta saliciperda* Felt.
Subglobose galls, the surface scarred, diameter 4 mm. *Mayetiola tumidosæ* Felt.

SOME NEW SPECIES OF WEEVILS OF ECONOMIC IMPORTANCE

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I beg the indulgence of my colleagues for combining in a single article purely taxonomic matter with a discussion of biologic and economic subjects. My plea is that the course I follow shows in a rather striking manner the close interrelationship between the economic and systematic branches of our science.

In a recent publication on the "Parsley Stalk Weevil (*Listronotus latiusculus* Boh.)," Dr. F. H. Chittenden cites examples of serious damage done by the semi-aquatic weevils *Listronotus appendiculatus* Boheman and *Notaris puncticollis* LeConte to cabbage in Ohio, and by *Listronotus latiusculus* Boheman to parsley in Virginia. He cites in addition, the tendency of the genus Sphenophorus to attack corn (Bur. Ent., bul. 82, part II, p. 14). These are all examples of the results of planting crops on newly drained land, when weevils which normally inhabit marshes have depredated on cultivated crops.

This brief notice describes a phenomenon in the biologies of weevils which is by no means uncommon, although perhaps not well understood as yet.[1] There are among our American weevils several very sharply defined groups of forms without wings or with rudiments of wings only. The classification of LeConte and Horn overlooks this important character and by raising other characters to primary importance has obscured it and dissociated what appear to the writer to be nearly related forms. The majority of these wingless weevils pass their developmental period in the ground at the roots of plants. Whenever it happens that land is cleared, and the plants eliminated have been the hosts of multitudes of these weevils, it is almost certain

[1] This paper deals only with weevils, however workers in other groups will recognize the existence of the same phenomenon.

that the planted crops will suffer from weevil depredations. In some cases it is probable that the life cycle of these weevils is more than one year and hence it may not seem apparent that clearing the land is responsible. If the plants attacked are trees or shrubs, these weevils may be easily handled by banding with some sticky substance.

As shown by the examples given and others in the literature of economic entomology the draining of marshes, or clearing of timber, or breaking up of meadows, or even the clearing off of under-brush have given rise to weevil inroads upon cultivated crops. Moreover such instances with winged as well as wingless species will be of frequent recurrence. Mr. Fred E. Brooks has recently written me of serious depredations of *Anthonomus scutellatus* Gyllenhal, upon grape blossoms in West Virginia, adding that from the grapes the weevils went to the rose bushes nearby. Dr. Chittenden's examples show the results of draining marsh lands. The breaking up of a lupine meadow infested by a species of Sitones and planting of a leguminous forage crop would without a doubt give rise to an attack from this weevil.

Even rotation of certain crops is dangerous. When *Chalcodermus æneus* Boheman, has been very injurious to cow-peas it is inadvisable to plant cotton, for the weevils will invariably depredate upon the cotton foliage and Dr. W. E. Hinds has demonstrated that they can breed successfully in a cotton square.

Still another important phase of the general problem we are discussing is the introduction of a cultivated crop into the vicinity of wild plants which are nearly related. If these wild plants have important enemies and the new crop encroaches upon them or directly or indirectly causes their eradication, the insect enemies are likely to find the cultivated crop a better medium for propagation than the variable wild plants. Bearing this point in mind it is not proper to plant cabbages, turnips, mustard or other crucifers on ground just cleared of an abundant wild crucifer. An example of what will happen is cited in the description of a new species of Ceutorhynchus given herewith. A similar example is the danger of planting apple, quince or pear orchards in the vicinity of a grove containing haw-trees (*Cratægus* sp.). Mr. Fred E. Brooks has just published an article on the insects of the apple in West Virginia in which he cites *Tachypterellus* (*Anthonomus*) *quadrigibbus* Say and *Pseudanthonomus cratægi* Walsh as important apple enemies. Both of these weevils and the quince weevil (*Conotrachelus cratægi* Walsh) are native to Cratægus. In this connection I should expect the advent of apples into Louisiana or South Texas to bring about the change of

Anthonomus nebulosus LeConte, and *Anthonomus pallidus* Dietz, both bud weevils, from Cratægus to the apple. The proximity of grape vineyards to woodlands containing woodbine and wild grape undoubtedly gave rise to the two grape pests *Ampeloglypter sesostris* LeConte, and *A. ater* LeConte. These examples might be multiplied many times, and I expect to cite all such cases in a list of the breeding habits of North American weevils now in preparation.

The recent discovery of several new species of weevils which have come into view as destructive to important crops is the reason for the present article. Four of these weevils have been transmitted by State Officials and it is due to them that descriptions be published so that they may use the notes in their reports. The proper elucidation of two of these weevils has necessitated a preliminary statement of a revised classification of our North American weevils. As many months of work is still necessary to the completion of this classification I can but indicate the direction it will take.

It has become necessary in the writer's opinion to drop the LeConte and Horn conception of the classification of the Otiorhynchidæ and to return to Lacordaire, accepting the modifications proposed by Stierlin, Sharp and other recent authors. It will be sufficient in the present article to limit the subfamily Brachyderinæ, which is almost the equivalent of Stierlin's Brachyderini, to those weevils with linear scrobes, directed beneath, contiguous anterior coxæ and prothorax without vibrissæ. The subfamily Otiorhynchinæ is the equivalent of Stierlin's Otiorhynchini and includes those weevils which have the scrobes variable, never at the same time, linear and directed beneath. By this system all of the wingless weevils with unequal abdominal segments, scaly antennæ and underparts, and with simple claws are grouped together in the Epicærini. The result is a group of weevils of similar appearance and with like biologies. Hence the economic treatment becomes much simplified for we find that a few definite rules can be laid down for the treatment of the whole tribe.

Family OTIORHYNCHIDÆ

Subfamily Brachyderinae

Tribe *Epicærini*

I. Side-pieces of mesosternum very unequal, the episternum larger and attaining the elytral margin, epimeron usually small, sometimes very small .... Group *Epicæri*
  a. Articular face of hind tibiæ glabrous, support of deciduous piece moderately prominent.

b. Antennæ stout, last joint of funicle short, broad and very close to club, first two joints of tarsi glabrous.......*Graphorhinus* Schönherr

bb. Antennæ more slender, joints of funicle conical, the last distant from the club; tarsi pubescent.......................*Epicærus* Schönherr

aa. Articular face of hind tibiæ scaly; support of deciduous piece very prominent; antennæ rather slender, club distinct....*Anomadus* Horn

II. Side-pieces of mesosternum diagonally divided and equal or very nearly so, episternum distant from the elytral margin, separated by the epimeron ....Group *Artipi*

c. Tenth elytral striæ entire.

d. Genæ feebly emarginate; anterior tibiæ not denticulate within but with a row of sharp spines; second segment of abdomen not longer than the two following.............................*Omileus* Horn

dd. Genæ strongly emarginate; anterior tibiæ denticulate within; second segment of abdomen usually as long or longer than the two following.

e. Tips of hind tibiæ with, at most, a double row of fimbriæ.

f. Second joint of funicle elongate, longer than first *Aramigus* Horn

ff. Second joint of funicle shorter than first......*Lepidocricus* n. g.

ee. Tips of hind tibiæ with oval scaly space; second joint of funicle elongate, longer than first.................*Phacepholis* Horn

cc. Tenth elytral striæ confluent with the ninth; second segment of abdomen longer than the two following; genæ strongly emarginate. *Artipus* Schönherr

Graphorhinus Schönherr

Graphorhinus vadosus Say is the only representative of this genus. It has been taken feeding on clover leaves.

Epicærus Schönherr

The genus Epicærus presents considerable difficulty in its study on account of the great variation in color pattern and the sexual differences. It seems probable that the many references of injury to economic plants charged against *Epicærus imbricatus* Say are applicable to a number of different species.

In general the females are characterized by the more inflated abdomen, the thorax broadest at base and the apical declivity generally concave. The males have the body more cylindrical, the elytra not inflated, the thorax broadest at middle and the apical declivity straight or convex, seldom shallowly concave. It is therefore erroneous to base a table of differentiation of species upon the widest part of the thorax.

Table of Species

A. Frontal fovea round; beak not sulcate and seldom even shallowly depressed on median line, not densely clothed with scales.

a. Frontal fovea small; beak medianly shallowly depressed; pronotal punctuation very fine, with few large depressions, median line broadly

depressed; elytral strial punctures large and irregular; scales rusty.......................................*mexicanus* Sharp

aa. Frontal fovea large or moderate; beak sometimes medianly shallowly depressed; pronotal punctuation fine with many large foveate depressions, median line depressed; strial punctures regularly arranged; scales variable in color; scales of beak densest in lateral depressions, sparse along median line...............*imbricatus* Say

B. Frontal fovea more or less elongate; beak more or less sharply sulcate on median line, densely clothed with scales.

b. Sixth funicular joint longer than wide, seventh longer than sixth; vestiture of scape not scaly at apex; elytra almost twice as long as wide; prothorax medianly sulcate..........................*texanus* Casey

bb. Sixth funicular joint hardly longer than wide; elytra short; vestiture of scape scaly at apex.

c. Elytra from one-half to two-thirds longer than wide.

d. Seventh funicular evidently longer than sixth; median line of prothorax sulcate; length 8–10 mm....................*sulcatus* Casey

dd. Seventh funicular hardly if any longer than sixth; median line hardly indicated; elytra about ½ longer than wide; length 4.5–6.5 mm. ....*lepidotus* n. sp.

cc. Elytra but slightly longer than wide..........*formidolosus* Boheman

(*Epicærus lucanus* Horn belongs in b.)

Epicærus mexicanus Sharp is a Mexican species extending into Texas at Brownsville.

Epicærus imbricatus Say is a Northern species occurring as far south as Arkansas, Oklahoma and North Texas to Dallas and Gurley. It is charged in the literature with serious depredations on apple, bean, beet, blackberry, cabbage, cherry, clover, corn, cotton, cucumber, gooseberry, muskmelon, onion, peach, pear, plum, potato, radish, raspberry, strawberry, squash, tomato and watermelon. Very possibly some of the other species of the genus were responsible for part of these records.

Epicærus texanus Casey is a Southwestern species occurring in the chaparral country of Texas. It has no serious charges against it as yet.

Epicærus lucanus Horn is a very large weevil recorded only from Lower California.

Epicærus sulcatus Casey is also Southwestern, probably coinciding in range with *E. texanus*.

Epicærus lepidotus n. sp.

Length 4.5–6.0 mm. Form oval, not very robust, sometimes quite slender, densely clothed with small round, lineolate, iridescent white to pale brown scales arranged in definite patterns. Beak very little longer than head, about as wide as long, broadly convex separated from flatter front by very slight transverse depression; tip of beak angularly emarginate, with a median

smooth space surrounded by a broadly ogival raised margin; median impressed line deep extending to interocular fovea; lateral impressions short, feeble; surface coarsely punctured at tip, remainder of beak closely squamose, with whitish scales and with sparse setigerous punctures; antennæ with scape scaly at tip; seventh funicular hardly if any longer than sixth. Prothorax wider than long; in shape varying for the sexes as in other species; apex and base truncate; disk convex, nearly even, with a very faintly indicated median line; surface densely squamose, with sparsely arranged setæ, the median line indicated by a slender vitta of ochreous brown scales on a broad white median vitta, at each side of this is a light brown vitta and a smaller one on the sides, the remainder of the surface is pale. Elytra oval, usually widest about the middle, never more than one-half wider than prothorax, about one-half longer than wide; striæ consisting of small distant punctures, very feebly depressed; intervals flat; surface closely squamose, with interspersed dark setæ, scales darker above, and pale on the inflexed sides, with four small basal spots, two irregular transverse vittæ and apex also pale; legs and under-side squamose, finely and sparsely clad with pale setæ.

Described from eight specimens collected by E. A. Schwarz at San Antonio, Texas, May 9 and 10. It is also at hand from Cotulla and Brownsville, Texas. Types in U. S. N. M. No. 13122.

Epicœrus formidolosus Boh. is known only from Florida.

Anomadus Horn

Anomadus obliquus Horn is from the Peninsula of Lower California. I have seen no records of its habits.

Omileus Horn

Omileus epicœroides Horn is a large and common east Texas species. In March, 1904, the fruit growers of eastern Texas suffered considerable damage to the foliage of peach trees from an outbreak of this species. Professor E. D. Sanderson found that it was normally an oak insect and that the greatest damage was to newly planted orchards on land just cleared off and surrounded by oak (Ent. News, vol. XVII, p. 210).

Aramigus Horn

Aramigus fulleri Horn is a very widely distributed and exceedingly injurious species. It breeds at the roots of plants and is recorded as a serious enemy of apple, blackberry, peach, plum, sugar-cane and strawberry. It attacks many economic plants of Hawaii. Mr. D. L. Van Dine recommends treatment that will be applicable to most of these weevils. When they are found breeding at the roots of plants, the use of carbon bisulphide in the soil or fertilizing with tobacco waste is recommended. From trees and shrubs the weevils may be ex-

cluded by wrapping with cotton bands. When on the plants spraying with arsenate of lead is recommended.

Aramigus tessellatus Say has been recorded as injurious to sweet potatoes.

Lepidocricus n. g.

Rostrum not longer than head, separated from head beneath by very sharp and deep constriction; genæ strongly emarginate; antennæ short, first joint of funicle longer than second, remaining joints moniliform; scales of thorax dull, arranged in circles upon the numerous approximate tubercles; strial punctures of elytra round but appearing linear because of closer scaly vestiture, each bearing a tiny seta; anterior tibiæ strongly denticulate within; tips of hind tibiæ with only a single row of fimbriæ apparent; second segment of abdomen considerably longer than the two following, with first suture angulate.

Name derived from λεπίς, scale + κρίκος, a circle, signifying a circle of scales with reference to the vestiture of the thorax. The type of the genus is *L. herricki* n. sp.

Lepidocricus herricki n. sp.

Form robust, oval, surface densely covered with grayish to brownish concave lineolately sculptured scales, with no striking color pattern. Head and rostrum about as long as thorax, medianly deeply canaliculate, surface longitudinally rugosely punctate, covered with cinereous scales and bristles, at tip, nearly naked. Prothorax broader than long, apex slightly narrower than base, sides very strongly convex, median line not indicated, surface closely covered with cylindrical tubercles, each with a deep bristle bearing puncture, thus resembling craters, the scales arranged upon these tubercles in circles, on some specimens forming a lighter band on each side of the median line, and with sides lighter. Elytra oval, about two and a half times as long as prothorax, striate, striæ with moderately close, coarse setigerous punctures which are always obscured and appear linear in a fully clothed specimen, intervals almost flat, each with a row of short bristles, surface densely covered with concave lineolately sculptured round to ogival scales. Body beneath sparsely clothed with small thin scales, but more densely with long white setæ; third and fourth abdominal segments strongly depressed. Legs densely scaly, and pubescent. Length 5–6 mm.

Described from five specimens loaned me by Professors Glenn W. Herrick and R. W. Harned; collected by a correspondent (J. B. Easter) at Easter in Monroe Co., Miss., May 7, 1904. Types in the U. S. N. M. (No. 13084) and also in the collection of Mississippi Agricultural College.

Professor Herrick writes that his correspondent said that these "weevils had made their appearance on his farm and were feeding on his young cotton, saying, 'it looks as though they were going to destroy the whole stand. It is something new in this section of the country.

They eat the leaves off the cotton and even eat it before it gets out of the ground.' Evidently the beetles were so destructive that the cotton had to be replanted, for on May 25, he writes again as follows: 'I would have written you before but was waiting to see what the insects would do to our second planting. The cotton is now up and I don't see any sign of them yet.'

"Nothing more was ever heard regarding the beetles and they probably did not again appear in numbers sufficient to attract attention. The outbreak is interesting however, especially since the species has shown an ability and an inclination to become a serious pest and might easily appear again over a larger area."

Phacepholis Horn

Table of Species

1. Beak deeply and angulately emarginate at apex; only the anterior tibiæ denticulate within.
   - a. Antennæ elongate; funicular joints elongate, the second much longer than the first and considerably longer than the two following. Prothorax squarely truncate, wider than long; vestiture brilliant metallic green to bluish green above............................*elegans* Horn
   - aa. Antennæ not so elongate, funicular joints elongate, the second very slightly longer than first if at all, and subequal to the two following; prothorax slightly obliquely truncate, slightly wider than long; vestiture white to grayish green.......................*pallida* n. sp.
2. Beak emarginate at apex but not deeply so; antennal funicular joints elongate, the second subequal to the first or but slightly longer; prothorax obliquely truncate; anterior and middle tibiæ denticulate within.
   - b. Elongate; anterior tibiæ internally strongly serrulate dentate; second abdominal segment a little shorter than the next two combined; vestiture white to light ochreous......................*candida* Horn
   - bb. Stout; anterior tibiæ with a very few isolated elongate teeth; second abdominal segment longer than the two following; vestiture brownish ....*obscura* Horn

Phacepholis elegans Horn. I have specimens which seem in every way typical from San Antonio, Victoria, Kerrville, Edna and Cotulla, Texas, all southwestern points in the chaparral country. Specimens were taken on cotton at Victoria and San Antonio.

Phacepholis pallida n. sp.

Length 4.5–6 mm. Body oval, robust, black but densely clothed with iridescent white to light green scales, and slight erect setæ, the general appearance being gray to grayish green. Head and rostrum nearly as long as the thorax; head not or very feebly constricted behind the eyes; densely covered with rounded, striate white to iridescent pink scales and upright, elongate, apically truncate, striate white scales; beak apically deeply emarginate;

median line deep and distinct to base of head; eyes very convex, moderately prominent. Antennæ not as elongate as in *elegans*, but with all funicular joints longer than wide, the second very slightly, if at all, longer than first, and subequal to the two following. Prothorax slightly wider than long, slightly obliquely truncate at apex, sides arcuate; disk moderately convex, moderately coarsely punctured; densely covered with the two kinds of scales described for the head. Elytra oval, sides feebly arcuate, surface striate, strial punctures moderate, not closely placed, intervals flat, densely clothed with both kinds of scales. Body beneath more sparsely clothed as above, in greenish specimens the under-sides are clothed with white; anterior tibiæ with strong elongate teeth; median tibiæ internally slightly roughened serrulate.

Described from five specimens collected at Corpus Christi, Texas, May 17, 1905, by A. C. Morgan on cotton. Also found at Victoria, Texas, on cotton. Type Cat. No. 13123 U. S. N. M.

Phacepholis candida Horn is known from Colorado and Kansas.

Phacepholis obscura Horn. On March 22, 1910, Professor Wilmon Newell of Texas received from R. E. Williams at Mineral Wells, Texas, a large number of these weevils with the following remarks:

"I am sending you today some bugs which have almost eaten up our spinach. They eat on plant, and at night or when cool they will be found under the dirt, find from 2 to 12 bugs under one plant."

This record places the genus Phacepholis in the same category as the other economic genera and indicates that the occurrence of these species on cotton may also be of importance.

Artipus Schönherr

Artipus floridanus Horn. This species is found commonly on *Baccharis halimifolia* and *Borrichia frutescens* in Florida but numerous authors have recorded serious injuries to the blossoms, young fruit, and leaves of citrus trees, especially limes, in Florida.

It seems probable that the recommendations of Mr. Van Dine for the control of *Aramigus fulleri* will be applicable to all insects of the tribe Epicærini which has been treated in its entirety for our North American fauna on the preceding pages.

Subfamily Otiorhynchinae

Tribe Trachyphloeini

Cercopeus Schönherr

The tribe to which this genus belongs has been limited in our North American fauna to four monotypic genera and it is therefore with considerable pleasure that I am permitted through the courtesy of Pro-

fessor R. A. Cooley and Mr. E. A. Schwarz to describe a second species in one of these genera.

Table of Species

Scales luteous to brown, with darker discal spot on elytra; length 3–5 mm. . . . . *chrysorrhæus* Say

Scales iridescent white to shining ochreous, slightly mottled on elytra but not forming a distinct spot; length 3–3.5 mm. . . . . *artemisiæ* n. sp.

Cercopeus artemisiæ n. sp.

Size 3–3.5 mm. Color black to piceous, densely covered above and below with round, slightly overlapping, white or ochreous, finely striulate, appressed scales, which are intermixed with long, fine, white setæ; elytral intervals uniseriately setigerous. Beak slightly longer and narrower than head, clothed with scales to tip, with a smaller interocular fovea, and a median line toward apex; scrobes superior, deep in front, shallow behind, not reaching eyes by a distance subequal to their own length. Antennæ rufous; scape reaching thorax, scaly and pubescent; club about equal to the last four funicular joints. Eyes rounded, moderately convex; ommatidia relatively large, separately convex, giving the appearance of a flattened raspberry. Thorax transverse, basally and apically truncate, laterally broadly arcuate. Elytra not one half longer than wide; humeri obliquely rounded; striæ as seen with scaly vestiture complete, very fine but sharp; intervals clothed with from three to five rows of closely placed pavement scales, but uniseriately setigerous. Under-sides densely scaly; front coxæ contiguous; middle coxæ very narrowly separated; intercoxal process truncate and transversely impressed before apex. Second abdominal segment about equal to two following, fifth longer. Femora and tibiæ densely scaly; anterior and median tibiæ strongly mucronate; tarsal claws strongly divergent.

Described from nine specimens collected by R. A. Cooley at Corvallis, Montana, May, 1909, injuring cherry trees, but evidently native to *Artemisia tridentata*. Prof. Cooley writes that the "species was reported doing considerable damage over large tracts of newly planted orchards. It was particularly injurious on cherry trees. I examined the trees and traced the beetle to a species of *Artemisia tridentata* I think. I believe the species feeds normally and breeds on this plant. I accounted for its presence in the orchards by the fact that its normal food plant was cleared off, leaving little else for the beetle to eat other than the fruit trees." Type Cat. No. 13083 U. S. N. M.

Family CURCULIONIDÆ

Subfamily Ceutorhynchinae.

Ceutorhynchus Germar

The following species belongs in the true Ceutorhynchus, with 7-jointed antennæ, and in Dietz's "squamatus group." The first section of that group can be distinguished as follows:

1. Above shining, finely pubescent with scattered larger scales.
   a. Elytra without rows of acute granules.
      b. Scutellar spot of elongate whitish scales........*anthonomoides* Dietz
      bb. Scutellar spot and transverse fascia behind the middle of the elytra of large white oval scales.....................*squamatus* LeConte
   aa. Elytra with rows of acute granules; third joint of tarsi broadly bilobed; thorax with median antebasal and postapical depressions, the former clothed with elongate white scales; scutellar region not clothed with white scales ....*lesquerellæ* n. sp.
2. Above densely scaly or coarsely pubescent.

Ceutorhynchus lesquerellæ n. sp.

Length 2 mm. Oval elliptic, black throughout, clothed with extremely fine inconspicuous pubescence above and with rather sparse elongate scales, densest on thorax, below. Beak moderately slender, regularly and rather strongly curved, cylindrical, minutely pubescent to middle, striate and punctured from the base to the insertion of the antennæ, more remotely puncted toward the apex. Head flattened, rather coarsely punctured. Prothorax about one-half wider than long, almost twice as wide at base as at apex, convergently rounded on the sides, strongly constricted at apex, ocular lobes distinct, lateral tubercles small, acute, disk with deep antebasal and postapical impressions, the former bearing the only spot of condensed scaly vestiture visible from above; disk uniformly, closely and coarsely punctured; scutellum invisible. Elytra a little wider at base than prothorax; humeri obliquely rounded, striæ impressed but very confusedly punctured; interspaces very little wider, convex, each with a row of acute granules which become longer and tuberculiform towards the declivity. Under-side densely and coarsely punctured, mesosternum and side-pieces densely, the rest of surface less densely clothed with large, elongate scales, smaller on the abdomen. Femora arcuate; tibiæ a little widened towards apex; tarsi moderate, first and second joints elongate, third broadly bilobed, fourth joint projecting about the length of the third.

Types in U. S. National Museum No. 13085.

Described from four specimens received March 22, 1909, from Prof. Glenn W. Herrick, then State Entomologist of Texas, who reported them to be destroying cabbage plants as fast as they came up in seed beds at Whitewright, Texas. Two specimens of this species were collected April 18, 1906, at Wolfe City, Texas, by F. C. Bishopp. On April 3, 1909, Mr. E. S. Tucker found the weevil breeding abundantly in the crown of the crucifer, *Lesquerella gracilis* at Plano, Texas.

It is safe to assume that of the several new species herewith described this is the most dangerous and it will be looked for with interest this year.

I take occasion at this time to state that I have in preparation a complete revision of my former list of the breeding habits of North American weevils. Any assistance will be very gratefully acknowledged.

PLANT LOUSE NOTES, FAMILY APHIDIDAE

(Continued). Plate 24

By C. P. Gillette

SUBFAMILY APHIDINAE[1]

Chaitophorus betulæ Buckt. (?). Figs. 1, 2a, 3.

Buckton's description of this species was from fall apterous forms only and does not characterize very correctly the summer form of the louse that I am referring to this name. I believe it is the only *Chaitophorus* that has been referred to the birch. This species was found very abundant on the leaves of *Betula alba* at Portland, Lansing, Albany, Geneva and Denver.

This louse is almost a *Myzocallis* having very little hair on the antennæ and having cylindrical or somewhat constricted cornicles, without flange, that are rather longer than the transverse diameter. In other respects it is plainly *Chaitophorus*. The cauda is very small, slightly knobbed, the anal plate hardly bilobed, the body short and stout, the young do not have capitate hairs, and the apterous viviparæ have a row of sensoria on third joint of antenna, a very unusual occurrence.

In arranging the following species belonging to the tribe *Callipterini*, I have endeavored to place them in the genera that would be indicated by the type species designated in Mr. Wilson's "List of Genera," etc. Vol. XXI, p. 147, of *Entomological News*.

Chromaphis juglandicola (Kalt), Fig. 4. Five to seven oval sensoria distributed along entire length of third joint, and about equidistant. Often two large sensoria on sixth joint. Legs pale with a conspicuous black spot a little before the distal ends of the hind femora. Koch re-described this species under the same name.

On *Juglans regia*, Washington, D. C., and Dundee, Ore. At Dundee leaves were very sticky with the honey dew, but most of the lice had disappeared.

Eucallipterus tiliæ (Linn.), Fig. 5. Taken at Lansing, Detroit and Geneva from the under side of the leaves of basswood, *Tilia americana*. Common, but nowhere seen abundant.

Monellia caryæ (Monell), Fig. 6. Specimens taken from hickory, *Carya alba*, at Portland and Detroit, and from walnut, *Juglans nigra*, at Fort Lee.

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[1] Should have been inserted before *Melanoxantherium* on page 385, Vol. 2.

Monellia marginella (Fitch), Fig. 7. Specimens of this species which answer fully the description by Fitch, and which seem to the writer to be quite distinct from *caryella*, were taken at Portland, Detroit and Kansas City from leaves of *Carya alba*, upon which they were quite plentiful. The sensoria on basal half of joint 3 of the antenna vary from 4 to 7 in number.

Monellia maculella (Fitch) (?), Fig. 8. What I take to be this species has about 6 longitudinal rows of small blackish tubercles upon the dorsum of the abdomen, and both anterior and posterior femora have a black ring or spot a short distance from their distal ends, but the tarsi are not perceptibly blackish and the maculations upon the wings as described by Fitch, are indistinct or lacking in my specimens, all of which are in balsam.

Taken at Detroit on *Carya alba*, and at Lansing, Washington, D. C., and Fort Collins, Colorado, on *Juglans nigra*.

Myzocallis bella (Walsh), Figs. 9, 10. This very handsome lemon yellow species, with wings that have heavy black costal margins and very small costal cells, was taken at Portland, Detroit and Rochester, apterous and alate, on the upper side of the leaves of *Quercus rubra*. The apterous females have a double row of large black spots upon the dorsum of the abdomen, there being about seven to ten spots in each row and all closely placed. In addition, there are numerous stout capitate hairs over the body rising from tubercles. The antenna of an alate female taken at Rochester is shown at figure 9. The apterous females vary from yellow to a rusty brown in color, and have conspicuous white powdery patches above upon the vertex of the head and upon lateral margins of meso-thorax and abdomen.

Myzocallis walshii (Monell), Fig. 11. This species, which seems at first to be a miniature of *M. bella*, was correctly considered to be quite distinct by Mr. Monell. The very long antennal filament exceeding even the third joint in length would alone separate this species from *bella*. The capitate hairs are long and strong. This was a common species, but was noted only at Lansing, Portland and Geneva on *Quercus rubra*.

Myzocallis asclepiadis (Monell), Fig. 12. This species was taken in good numbers, both alate and apterous, from *Asclepias* sp. at Chicago, Detroit and Geneva. It seems to be readily separated from an allied species, also occurring upon the milkweeds, by the long antenna, usually fully as long as the body, and the longer antennal spur, which, though variable, always distinctly exceeds the sixth joint.

Calaphis castaneæ (Fitch), Fig. 13. At Lansing, Fort Lee, Wash-

ington, Webster and Springfield, both alate and apterous viviparæ were taken. This is a pretty lemon yellow species with antennæ beyond second joint, black, with first and second sectors and the inner margin of the stigma conspicuously black, and with 10 to 12 circular sensoria on the very long third joint of the antenna.

Myzocallis trifolii (Monell), Figs. 14, 15. What seems with little doubt to be this species was taken in moderate numbers on the under side of leaves of red clover at Lansing, Geneva, Albany and Washington, D. C. The third and fourth joints of the antenna are in the ratio of about 4 to 3 in the specimens taken, instead of being in the ratio of 2 to 1, as originally described. The apterous viviparæ are very tuberculate and have what rarely occurs — a row of sensoria on the third joint of the antenna.

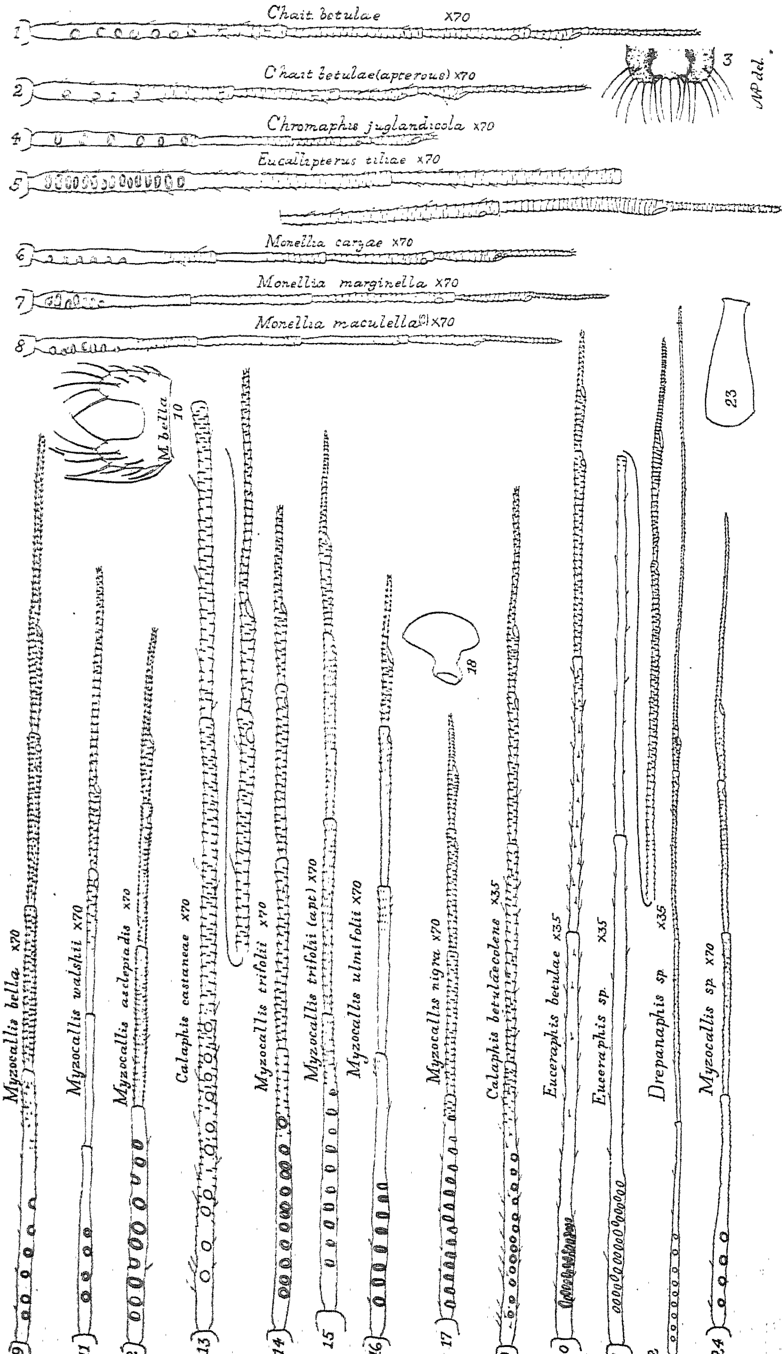
Myzocallis ulmifolii (Monell), Fig. 16. Taken at Chicago, Lansing, Portland, Mich., Detroit, Rochester, Geneva, Albany, New York City, Washington and Portland, Ore. This is an abundant species on elms in Colorado also, wherever the elm is planted. The dainty white lines upon the dorsum, the decidedly transverse sensoria on the third joint of the antenna, and the four long dorsal spines upon the dorsum of the abdomen, seem to be sufficient characters to separate this from allied species.

Myzocallis (?) *caryæfoliæ* (Davis), Figs. 17, 18. Taken on *Carya alba* at Kansas City, and Rochester, and sent to me by Mr. J. J. Davis from hickory at Lake Forest, Illinois, 6–24–'09. Taken on both upper and lower surfaces of the leaves of *Carya alba,* fairly common. Body short, very dark in general color, almost black, but with conspicuous white markings, and the entire under surface of the body powdered with white. There are strong erect spines or tubercles upon the dorsum of the abdomen and the costal margin of the wing has two distinct dusky spots, one at each end of the stigma. The antennal spine is distinctly shorter than joint 6.

Myzocallis (?) sp., Fig. 24. A small, pale yellow species, with pink cross-band on metathorax and with some pink color upon pro- and meso-thorax, with antenna longer than the body and upon no frontal tubercles, with spur more than twice the length of sixth segment, with two long stout erect spurs on dorsum of abdomen and with wing veins and stigma all somewhat dusky. Rather common upon the under surface of leaves of *Quercus alba* at Georgetown, D. C.

Calaphis betulæcolens (Fitch), Fig. 19. Specimens were taken at Geneva on *Betula alba-laciniata.* The specimens agree well with Fitch's description and with specimens that Mr. Monell sent me from

Plate 24



Antennæ of Callipterini

St. Louis, Missouri. We have taken the apterous viviparæ of what seems to be this species in Colorado at Fort Collins (foothills), and at Manitou upon leaves of the mountain birch, *Betula fontinalis.* See Fig. 19 for characters of antenna.

Euceraphis betulæ (Koch), Fig. 20. This peculiar species, with all parts of body, legs and antennæ covered with a delicate waxy secretion resembling wool, was a common species on the white birch. Specimens were taken at Lansing, Portland, Detroit, Geneva and Denver. The writer also took two males and oviparous females at Manitou, Colorado, October 20, 1908, on the native birch, *Betula fontinalis.*

Euceraphis sp., Fig. 21. A somewhat allied but plainly distinct woolly species of this genus was taken on *Alnus oregonia,* at Portland, Ore., August 20, 1909. The species was common but sporadic in habit. The antenna is extremely long, being more than twice the length of the long, slender body. We have the same species from the foothills near Fort Collins. See Fig. 21.

Drepanaphis monelli (Davis), Figs. 22, 23. A species with a stout pair of dorsal spines united for a considerable distance in the basal portion, and with antennal spur as long as joints 4, 5 and 6 together. On under side of leaves of horse chestnut, *Æsculus glabra,* at Washington, D. C., abundant.

This is the most remarkable filamentous antenna that I remember to have seen in the *Aphididæ.*

Plate 24—Antennæ of *Callipterini.* all alate except figures 2 and 15.—1 and 2 antennæ of alate and apterous viviparæ, and 3, cauda and anal plate of *Chaitophorus betulæ;* 4, *Chromaphis juglandicola;* 5, *Eucallipterus tiliæ;* 6, *Monellia caryæ;* 7, *Monellia marginella;* 8, *Monelila maculella;* 9, antennæ, 10, anal plate of *Myzocallis bella;* 11, *Myzocallis walshii;* 12, *Myzocallis asclepiadis;* 13, *Calaphis castaneæ;* 14, alate; 15, apterous *Myzocallis trifolii;* 16, *Myzocallis ulmifolii;* 17, antennæ, 18, cornicle, *Myzocallis nigra;* 19, *Calaphis betulæcolens;* 20, *Euceraphis betulæ;* 21, *Euceraphis* sp.; 22, *Drepanaphis* sp.; 23, cornicle of preceding; 24, *Myzocallis* sp.

Miss M. A. Palmer, *Delineator.*

FURTHER NOTES ON THE APHIDIDAE COLLECTED IN THE VICINITY OF STANFORD UNIVERSITY

By W. M. Davidson

In the Journal of Economic Entomology (Vol. II. No. 4, August, 1909), I listed the Aphididæ studied during a year's observation in this region. During the year just passed I have continued my studies on this family and am now able to increase considerably the number of species tabulated in my former report. Mr. J. J. Davis (Annals of the Ent. Soc. of America, Vol. I, 4 and II, 1) has lately reported *Callipterus* (*Pterocallis*)*tiliæ,* an European insect, from America, thus corroborating my inclusion of this species in my former paper. I include a list of Aphididæ so far reported from California. This paper was prepared in the Entomological laboratories at Stanford University.

Phylloxera vastatrix Planchon. This species was formerly abundant in California but of late years its numbers have diminished very considerably. On *Vitis.*

Chermes pinicorticis Fitch. This insect is often very destructive to young trees, sometimes killing them. On *Pinus maritima.*

Chermes coweni Gillette. I have taken this species on a young Douglass spruce at Palo Alto. On April 13 of this year I noticed a swarm of Lampyrid beetles (kindly determined for me by Mr. W. M. Mann as *Podabrus tomentosus* Say) flying around the aphids and at times settling among them. Several times during the following week I observed this same procedure, although in the morning the beetles were always quietly feeding on the lice while in the evenings they were very active and did not remain settled for more than a few moments at a time. I counted one evening forty of the Lampyrids at work. When disturbed they drop to the ground but recover themselves just before striking it and fly off. I have noticed a few of the fire-flies attacking *Lachnus occidentalis* and *Macrosiphum rosæ,* but never in large numbers.

Pemphigus betæ Doane. On the roots of dock (*Rumex occidentalis*) and of other related plants.

Pemphigus populitransversus Riley. This species was wrongly called *P. populicaulis* in my former paper. Found in large numbers on *Populus trichocarpa.*

Pemphigus ranunculi sp. nov. Alate female (mounted in balsam). Head, meso- and meta-thorax black. Prothorax olive. Antennæ

widely distant, dusky, with the basal half of the joints paler. Third joint with 25, fourth with 8, fifth with 6, sixth with about 3 transverse sensoria. Unguis of sixth joint about one seventh as long as rest of joint. Eyes black, ocular tubercles prominent. Prothorax without lateral tubercles. Meso-thorax with four small pale spots arranged in a transverse row. Legs dusky. Abdomen green, with four rows of darker disk-like spots on the dorsum. These are apparently glands for the excretion of the flocculent material which this insect exudes. Body broadest at the fourth segment. Cornicles absent. Last abdominal segment drawn out and blunted. Wing large; stigma short, green. Insertions and veins greenish. Sub-costa duskier. Third discoidal absent at the base. Hind wings with two discoidals arising a very short distance apart. Lower side of thorax black. Beak pale, slender, reaches second coxæ.

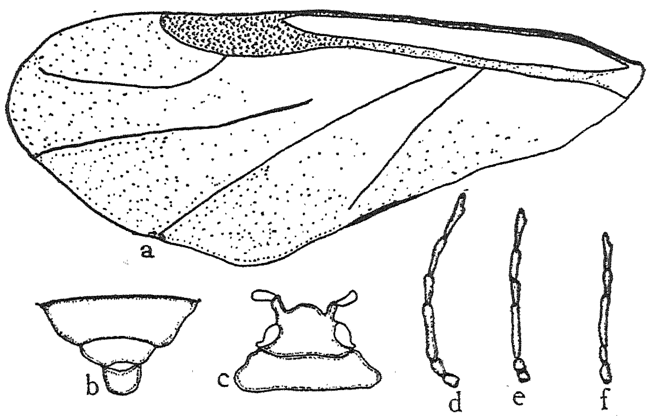


Fig. 28. *Pemphigus ranunculi.* Alate female; *a*, wing; *b*, tip of abdomen; *c*, head and prothorax; *d*, antenna; *e*, antenna of wingless female; *f*, antenna of young (original).

Pupa. Entirely green except wing-cases, antennæ, legs, and tip of last abdominal segment, which parts are slightly dusky. Eyes black. Antennæ as in the winged form.

Apterous viviparous female. Green. Shields on head, antennæ, legs, tip of abdomen and beak dusky. Antennæ barely one third the length of body. There are four rows of circular dusky areas on the dorsum of the abdomen as in the alate insect. Compound eyes very small, lateral, black. Taken in March on the stalks of the buttercup (*Ranunculus californicus*) where it congregates in great numbers. The insects cover their whole body except the head with a bluish flocculent material.

MEASUREMENTS

	Alate female	Apterous viviparæ
Length body,	3.1 mm.	3.2 mm.
Breadth body,	1.25 mm.	1.35 mm.
Wing expanse,	8.6 mm.	
Antennæ I,	.12 mm.	.09 mm.
II,	.15 mm.	.11 mm.
III,	.45 mm.	.30 mm.
IV,	.18 mm.	.07 mm.
V,	.21 mm.	.12 mm.
VI,	.22 mm.	.16 mm.

Pemphigus populiconduplifolius Cowen. Making galls on the poplar (*Populus trichocarpa*) in April. The stem mother is olive green, with darker longitudinal stripes. The eyes are small and black. The terminal portion of the abdomen is rather bristly. Cauda and cornicles absent. Beak just reaches second coxæ. The head is black, the antennæ hyaline, and the legs dusky. I doubt if the specimens examined were full grown so do not give any measurements.

Pemphigus populimonilis Riley. Abundant in Tulare County on *Populus fremonti* during the summer months at least.

Schizoneura lanigera Haus. On cultivated apple.

Schizoneura querci Fitch. Found in considerable abundance on the live-oak (*Q. agrifolia*).

Schizoneura americana Riley. Several years ago this insect was so abundant on the elms on the Stanford University campus as to almost kill the trees. At the present time it is not at all common.

Lachnus viminalis Fonsc. On *Salix* sp. Much parasitized by an *Ephedrus*.

Lachnus abietis Fitch. This large aphis is at times extremely common and at other times it appears to be almost totally exterminated by Syrphid larvæ. I have never found any winged forms although my observations on colonies of the Lachnus have extended over eighteen months. On *Abies concolor*.

Lachnus pini-radiatæ Davidson. On the needles and twigs of *Pinus radiata*.

Lachnus occidentalis Davidson. Abundant on the smaller branches and twigs of the spruce (*Abies grandis*) secreting a woolly material which causes the twigs to assume a bluish color. Although I have had colonies under observation for two years I have never seen the winged form. The Syrphid flies *Syrphus arcuatus* and *S. opinator* exact a very large toll from this aphid and are themselves frequently parasitized by a large Braconid.

Lachnus alnifoliæ Fitch. On the under side of the leaves of *Alnus rhombifolia.*

Cladobius saliciti Harris. The eggs of this species are deposited in large quantities on the twigs of willow or poplar in November These hatch before the end of January, the newly-hatched larvæ assembling in masses at certain places to feed on the twigs. The leaves of the tree do not develop for two weeks after the insect hatches. In the fall this insect increases with great rapidity notwithstanding the heavy toll exacted by an *Aphidius.*

Cladobius rufulus Davidson. On *Populus* and *Salix.*

Chaitophorus viminalis Monell. I have taken this species in both sexes in the fall and as late as late November. It feeds on various species of willow.

Chaitophorus populifoliæ Fitch. The colonies of this species have the largest numbers of individuals just before the leaves of their food-plant begin to fall. At this time there are two types of apterous viviparous females, both green, but one paler than the other. The paler variety gives birth to the small red males, while the darker form begets females winged and wingless. The males are winged and are of a claret color, quite a little smaller than the alate females, which latter are green. Males begin to emerge fully winged from the 25th of October on. At this time males and females were about equal in numbers and remain so until the leaves drop, when all disappear.

The alate male. Length, 1.85 mm. Breadth, .85 mm. Wing expansion, 5. mm. Antennal joints—III, .45 mm.; IV, .28 mm.; V, .22 mm.; VI, .08 mm.; VII, .4 mm. Antenna yellow, last three joints red. Sensoria on all joints except I, II and VII. Eyes bright red. Head, prothorax, thoracic lobes dusky red. Pale part of the prothorax flesh-colored. Legs yellow, hind femora reddish. Abdomen brick-red, with a darker transverse dorsal bar on each segment attaining the margin on the two caudal segments. Cornicles yellowish-red, expanded at the base, slightly longer than broad at their bases. Tail small, globular, gray. Caudal appendage pale, drawn out. Wings large, third discoidal obsolete at base. Insertions of wing yellowish. Stigma gray. Veins reddish-brown.

COMPARATIVE MEASUREMENTS OF THE ALATE MALE AND FEMALE

	Male	Female
Length body,	1.45 mm.	2.2 mm.
Breadth body,	.65 mm.	1.05 mm.
Antennæ,	1.30 mm.	1.25 mm.
Cornicles,	.075 mm.	.08 mm.
Expanse wings,	5.2 mm.	6.15 mm.

Chaitophorus nigræ Oestl. (?). I took a small black Chaitophorus

which has certain affinities with this species and may be the same. Only apterous forms were seen. On *Salix*.

Chaitophorus negundinis Thos. I took this insect in considerable abundance on the under side of leaves of *Acer negundo* in April. Both alate and apterous forms were present, but I could not find any males so early in the year. On the day on which I first noticed the aphid there were a few large yellow wingless forms which were presumably stem mothers left over. Towards the end of this month I took a number of the pale leafy dimorphs.

Phyllaphis fagi Linn. One specimen, an apterous female, taken on the under side of a copper beach at Palo Alto in April.

Idiopterus nephrelepidis Davis. On greenhouse ferns. Probably imported from the tropics on ferns. The insect was collected here some years ago but is not to be found at the present time.

Callipterus castaneæ Buck. On chestnut (*Castanea*).

Callipterus betulæcolens Fitch. On *Betula* sp.

Callipterus caryæ Monell. On cultivated walnut.

Callipterus arundicolens Clarke. On bamboo (*Arundo*).

Callipterus ulmifolii Monell. On *Ulmus americana*.

Callipterus tiliæ Linn. On *Tilia americana*. The stem mothers in spring are very pale and immaculate.

Callipterus quercus Kalt. I am sceptical as to the identity of this Callipterus found at Palo Alto on both the blue oak (*Quercus douglasii*) and on the white oak (*Quercus lobata*). It seems very near Kaltenbach's species, having the three pairs of tubercles on the dorsum and otherwise resembling it. I cannot satisfactorily compare it to any described American species. There are several English oaks near the trees infested and on one of these I found a very pale *Callipterus*, apparently *C. quercus*. Thus it is possible that the insect came on the young oaks when they were imported. However, I found this same species on the black oak (*Q. californica*) on the hills around San José where I found no English oaks although some doubtless existed in the valley towns below.

Aphis albipes Oestl. Found in April on the tender stalks and in curled leaves of the snowberry (*Symphoricarpus racemosus*). A striking insect much preyed upon by Syrphus flies.

Aphis brassicæ Linn. Common everywhere but checked, successfully at least in Santa Clara County, by its parasite *Diæretus californicus* Baker. On cruciferous plants.

Aphis rumicis Linn. Taken on the terminal shoots of ivy. An extensively parasitized species.

Aphis medicaginis Koch. On *Medicago denticulata*.

Aphis ceanothi Clarke. On tips of twigs of *Ceanothus cuneatus.*

Aphis lutescens Monell. Taken in great quantities on milkweed (*Asclepias mexicana*).

Aphis cratægifoliæ Fitch. Found in the fall in large numbers on the leaves of *Cratægus oxycantha* planted along the sidewalks in the towns of San José and Palo Alto. I could not find any alate forms but procured a large number of the black, oval, shining ova whence hatched the first spring brood of larvæ. I kept the twigs in water and noticed the first larva emerge on the 7th of February just as the buds were swelling. A week later a dozen larvæ had hatched. The young are paler than the adults and feed on the opening buds. Alate forms appeared in April.

Aphis nerii Kalt. This insect was taken in Sonoma County on oleander.

Aphis bakeri Cowen (?). A doubtful species on *Senecio vulgaris.*

Aphis mali Fabr (?). A species very similar to *A. mali* on the terminal leaves of *Laurus laurustinus,* causing them to curl.

Hyalopterus arundinis Fabr. On the plum in great quantities in May.

Siphocoryne avenæ Fabr. Sparingly attacking wheat and oats.

Siphocoryne salicis Monell. This is not a common insect but it sometimes occurs in large numbers on single trees.

Siphocoryne xylostei Schrank. Taken in abundance on the terminal leaves of the cultivated honeysuckle (*Lonicera* sp.) where it curls the foliage and renders the plant very unsightly. Syrphid larvæ prey extensively on it.

Siphocoryne foeniculi Pass. Taken in November on fennel (*Foeniculum vulgare*). Quite generally parasited by a Braconid.

Siphocoryne conii Davidson. Throughout the year feeding on *Conium maculatum.* It prefers the flowers and seeds to the leaves. Parasitized by an *Aphidius.*

Drephanosiphum platanoides Schr. This most interesting insect occurs in the summer and fall upon the European sycamore (*Platanus orientalis*). I have not been able to locate the eggs during winter, notwithstanding the fact that oviparous females were very common in November. The oviparous female is peculiar in having its ovipositor protruding considerably.

Rhopalosiphum tulipæ Thos. On leaves of tulip (*Tulipa*).

Rhopalosiphum nymphaeæ Linn. Common on *Polygonum* sp.

Rhopalosiphum violæ Pergande. A beautiful insect which occurs on leaves of cultivated violet, generally on the under side.

Rhopalosiphum lactucæ Kalt. At first I thought this insect was

R. dianthi but closer examination showed it to be *R. lactucæ,* an European form lately reported from America, (Canadian Entomologist, Vol. XXXIII, No. 3, 1901. E. D. Sanderson). Taken sparingly on *Sonchus oleracea.*

Rhopalosiphum berberidis Kalt. I took the oval, black eggs in January on the stalks of barberry (*Berberis vulgaris*). At this time oviparous females were still producing eggs. Eggs hatched from January 20 on, producing almost entirely apterous forms. By April winged and wingless viviparæ were abundant on the under side of the leaves.

Rhopalosiphum dianthi Schrank. This species is abundant on several plants in Santa Clara County. Among its hosts are Groundsel (*Senecio vulgare*), *Sonchus oleracea* and *S. asper,* celestial pepper, forget-me-not (*Cyanoglossum*), and *Amsinkia.* I have bred several parasites from *R. dianthi,* among these a minute wingless dipterous insect.

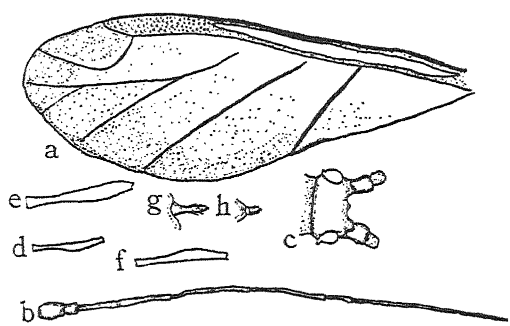


Fig. 29. *Rhopalosiphum arbuti.* Alate female; *a,* wing; *b,* antenna; *c,* head; *e,* cornicle; *g,* cauda; *d,* cornicle of young; *f,* cornicle, and *h,* cauda of apterous female (original).

Rhopalosiphum arbuti sp. nov. Alate male. Length of body, 1.8 mm. Breadth of body, .48 mm. Wing expanse, 6.1 mm. Cornicles, .50 mm. Antennæ—III, 52 mm.; IV, .40 mm.; V, .35 mm.; VI, .12 mm.; VII, 1.05 mm. General color reddish-yellow, newly emerged individuals pale green throughout. Antennæ on small frontal tubercles, half as long again as the body, dusky except joints I and II and base of III. Seventh joint much the longest, exceeding third and fourth together, very fine. Joints III and IV with numerous small sensoria. Eyes red. Head, prothorax, thoracic lobes, scutellum pale brown. Pale part of prothorax and abdomen yellowish-brown, latter with several undefined dusky bars on the dorsum and with dusky lateral spots and blotches. Abdomen broadest just anterior to the

cornicles. Cornicles long, slender, contracted at base for half their length, clavate, dusky brown, five times the metatarsi in length, extending half their length beyond the tip of the abdomen. Style golden yellow, tapering, about as long as the tarsi, pilose. Legs long, slender, very dusky except for anterior two-thirds of the femora and the coxæ, which are pale yellow. Beak just exceeds third coxæ. Wings hyaline, large. Insertions and sub-costa pale greenish yellow. Stigma short, gray. Veins dark brown, first two discoidals robust, third discoidal obsolete at base. Stigmatic vein curved regularly. Second branch of cubitus slightly shorter than the part between the forks.

Pupa. Pale green. Antennæ half again as long as body, green with black tips to the joints. Eyes crimson. Style conical. Abdomen with reddish areas on the sides. Size 1.3 x .55 mm.

Apterous viviparous female. Pale yellowish-green. Head in the mature insect with reddish tinge, small. Antennæ slightly longer than the body, situated on evident tubercles, pale except articulations and last two joints, which are dusky. Seventh joint almost as long as joints III, IV, and V together. Eyes bright red. Abdomen very pale, oval. Cornicles slightly dusky, clavate, broadest just beyond the middle. Cauda pale, short, conical. Legs pale, concolorous with the body and cauda, tarsi and tibial apices dusky. Beak with a brown tip, reaches third coxæ. This species is common throughout the year on the under surface of the leaves of the Madrone (*Arbutus menziesii*). It is quite extensively preyed upon by Braconidæ.

Measurements of the apterous female: Length body, 1.55 mm.; breadth body, .68 mm.; cornicles, .45 mm.; antennæ III, .35 mm.; IV, .30 mm.; V, .30 mm.; VI, .10 mm.; VII, .80 mm.

Alate female: Length of body, 2.0 mm.; breadth of body, .9 mm.; expanse of wings, 6.85 mm.; cornicles, .5 mm.; cauda, .2 mm.; antennæ III, .5 mm.; IV, .45 mm.; V, .42 mm.; VI, .14 mm.; VII, 1.05 mm.

Alate female. Pale green, with some indefinite dusky markings on the abdomen. Head, prothorax, scutellum, and thoracic lobes brown. Eyes red. Antennæ brown, joints III, VI, VII, and distal half of IV and V dark olive green, on frontal tubercles. Joint III has about 20 small sensoria, joint IV about 8 smaller ones. Cornicles brown, clavate, broad at the base then narrowing for half their length and expanding distad, reaching their widest at apical fourth, then slightly narrowing to the apex. Cauda two-fifths the length of cornicles, slightly upturned, concolorous with the abdomen with the tip dusky. Legs long, light brown; tarsi, distal half of femora, proximal half of tibiæ dark brown. Wings large; stigma gray; veins dark brown, thick, the first discoidal with a smoky border, also the second, but the border less conspicuous. Beak pale, the tip black, reaching second coxæ.

Myzus rosarum Walk. Taken sparingly in the fall on wild rose (*Rosa californica*).

Myzus persicæ Sulz. In the spring on peach.

Myzus vincæ Gillette. On the youngest leaves of periwinkle (*Vinca major*).

Macrosiphum tulipæ Monell. On petals and leaves of *Tulipa*.

Macrosiphum rosæ Reaum. Very abundant on the young leaves and buds of cultivated rose. Both the red and green forms are common. I bred *Syrphus ribesii* from larvæ feeding on this Aphid.

Macrosiphum californicum Clarke. Found occasionally on the young twigs of willows (*Salix* sp.).

Macrosiphum pisi Kalt. Taken on *Vicia* sp., cultivated bean and *Urtica holoserica*.

Macrosiphum sonchella Monell. On *Sonchus oleracea*. Not nearly so common on sow-thistle as *Rhopalosiphum dianthi*. Both insects are to be found together on the same plant.

Macrosiphum acerifolii Thos. This beautiful insect occurs on *Acer dasycarpum*.

Macrosiphum citrifolii Ashm. Taken at Lindsay, Tulare County, in the summer, where it is well held in check by its insect enemies, especially by internal parasites.

Macrosiphum orthocarpi Davidson. Found among the flowers of owl-clover (*Orthocarpus purpurascens*) in April.

A list of species reported from California which have not been taken by me

Schizoneura pinicola Thos.; on *Pinus radiata*, Berkeley.

Callipterus coryli Goetze; on hazlenut, Berkeley.

Aphis calendulicola Monell; on marigold, Berkeley.

Aphis gossypii Glover; on shepherd's purse, water-melon, Newcastle, Watsonville.

Aphis maidis Fitch; on sorghum and corn, Berkeley, Watsonville.

Aphis mori Clarke; on mulberry.

Aphis alamedensis Clarke; on greengage, Alameda County.

Aphis œnotheræ Oestl.; on *Oenothera bectiana* and *Epilobium*, Berkeley.

Aphis persicæ-niger Smith; on peach and plum, Placer County.

Aphis sorbi Kalt.; on apple, Placer County.

Phorodon scrophulariæ Thos.; on *Scrophularia* sp. Berkeley.

Phorodon humuli Schrank; on hops and prune in California.

Chaitophorus populicola Thos.; on *P. trichocarpa*, Santa Paula.

Lachnus californicus Essig; on pines, Claremont.

Pemphigus radicola Essig; on roots of *Amaranthus retroflexus* and *Solanum douglasii*. From the description of this species I am inclined to regard it as synonymous with *Pemphigus betæ* Doane.

Macrosiphum jasmini Clarke; on jasmine, Berkeley.

Macrosiphum lycopersici Clarke; on tomato, Berkeley.

Macrosiphum valerianiæ Clarke; on valerian, Berkeley.

Macrosiphum rhamni Clarke; on *Rhamnus californicus*, Lander.

Macrosiphum baccharidis Clarke; on *Baccharis* sp., Berkeley.

Bibliography of Aphididae

As Sanborn in his "Kansas Aphididæ" (University of Kansas Science Bulletin, Vol. III, No. 8) has so recently given a very com-

plete bibliography of the family, it is unnecessary to publish such a list here. The following works, however, may be cited as dealing particularly with western species:

A List of California Aphididæ. W. T. CLARKE. Can. Ent., Vol. 35.

Host-plant List of North American Aphididæ. T. A. WILLIAMS. Univ. Nebraska Special Bulletin No. 1. July, 1908.

Orchard Plant-lice and Their Remedies. C. P. GILLETTE and E. P. TAYLOR. Exp. Station of the Colo. Agr. Coll. Bull. 134. Sept., 1908.

A Few Orchard Plant-lice. C. P. GILLETTE and E. P. TAYLOR. Colo. Exp. Station Bull. 133.

Chermes of Colorado Conifers. C. P. GILLETTE. Proceedings of the Academy of Natural Sciences of Philadelphia. Jan., 1907.

Biological Studies in Three Species of Aphididæ. J. J. DAVIS. U. S. Dept. of Agr., Div. Ent., Technical series Bull. 12, part 8. Feb., 1909.

Two new genera and species of Aphididæ. J. J. DAVIS. Annals of the Ent. Society of America, Vol. II, No. 3. Sept., 1909.

Studies in Aphididæ I & II. J. J. DAVIS. Annals of the Ent. Society of America, Vol. I, No. 4; and Vol. II, No 1. Dec., 1908.

Aphididæ of Southern California. E. O. ESSIG. Pomona Journal of Entomology, Vol. 1, Nos. 1 & 4.

Notes on Aphididæ collected around Stanford University. W. M. DAVIDSON. Journal of Econ. Ent., August, 1909.

Scientific Notes

Elm leaf beetle (*Galerucella luteola* Mull.). This species was unusually abundant and destructive in the upper Hudson Valley, being very injurious from Poughkeepsie north to Cohoes, Stillwater and Greenwich. A record of serious injury, accompanied by numerous specimens, was also received from Mr. Frank T. Clark of Ticonderoga, N. Y. This is the northernmost record for serious injury by this beetle in the state of New York.

Snow-white linden moth (*Ennomos subsignarius* Hubn.). This insect has continued its depredations of the last two years in the Catskills, though the defoliated area is probably not so extensive as in 1909. There has been a marked falling off in the numbers of moths observed at lights in cities and village along the Hudson River, if one may accept as safe criteria, local newspaper notices supplemented by personal observation.

E. P. FELT

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1910

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints may be obtained at cost. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—EDS.

The dissemination of information is a most important function of the economic entomologist, since his efficiency is dependent in considerable measure upon the general adoption of his recommendations. We have in this issue a discussion of exhibition methods, with special relation to state and county fairs. There is much of value in the paper, though methods of service in Ohio may not be equally effective in other sections of the country. We believe most heartily in attracting first and then instructing, if the latter be possible. A well arranged exhibit collection should appeal to men from various sides. It is not sufficient to attract those who recognize their need for information. We should stimulate the appetite if necessary, though attractive features should not be allowed to dwarf and crowd the more instructive and practical portions of the exhibit. Every exhibit collection has its strong and its weak points. We believe this paper should be followed by others, discussing the problem from various aspects. The educational value of a well planned exhibit is certainly very great.

The gyspy moth has occupied a prominent place economically in America for the past twenty years. Enormous sums have been expended in attempts to exterminate the insect, and now large appropriations are being used in suppressive work. The experience of recent years has shown that not all the important factors governing the distribution of this insect were known. The paper by Mr. Collins establishes the possibility of small birds eating the eggs and dropping them in a viable condition in places remote from human habitation. Several colonies have been found under such conditions and this suggestive paper is of great value in indicating a possible method of distribution. It may be that there are other hitherto unrecognized agencies which play an important part in the dissemination of this pest. It is hardly necessary to add that the successful control of this as well as all other injurious species depends in large measure upon exact biological information. We cannot know too much about an insect pest.

Obituary

DR. CYRUS THOMAS

Dr. Cyrus Thomas, state entomologist of Illinois from 1875 to 1882, died at Washington, D. C., June 27, 1910, at the age of eighty-five years. His career was of a kind unusual even for its time, and now no longer possible. Beginning active life as a practising lawyer in southern Illinois, he became in succession a Lutheran clergyman, an assistant on the geological survey of the territories, a normal school science teacher, a state entomologist, and an ethnologist in the American Bureau of Ethnology at Washington, serving in this latter capacity for the last twenty-eight years of his long life.

He was born in Kingsport, in eastern Tennessee, July 27, 1825. After studying law in Tennessee, he removed to Jackson County, Illinois, in 1849, was admitted to the bar in 1851, and practised at Murphysboro until 1864. He then entered the ministry of the Evangelical Lutheran Church, and preached until 1869, when he was appointed entomologist and botanist to the Geological Survey of the Territories, under Doctor Hayden, serving in that capacity until 1873. From 1874 to 1876 he was teacher of natural sciences in the Southern Illinois State Normal School, then recently opened. He was appointed to the office of state entomologist April 13, 1875, and resigned early in 1882, to take effect June 30 of that year. For five years of this period he was also a member of the United States Entomological Commission.

He began to publish entomological papers, mostly in the *Prairie Farmer* of Chicago, as early as 1859, when he was still in active practice as a lawyer, and in the following year he engaged with B. D. Walsh in a spirited controversy, running through several numbers of that journal, concerning the life history of the army-worm. In the fifth volume of the Transactions of the State Agricultural Society, printed in 1864, are three prize essays on entomology by Walsh, LeBaron and Thomas, who afterwards became respectively the first, second and third state entomologists of Illinois. Doctor Thomas became one of the leading specialists on the *Acrididæ* of the United States, publishing a monograph of that family in the report of the Geological Survey of the Territories in 1873. Later he gave special attention to the *Aphididæ,* and his third report as state entomologist is one of the most important descriptive publications on that family which has ever yet appeared.

In his economic work in Illinois he was severely handicapped by the penurious policy of the state with respect to the entomologist's

office. In all his seven years' service he received nothing from the state treasury except his salary, and had no facilities for his work except those which he provided for himself and at his own expense. His official reports are consequently largely given to systematic articles, to résumés of pertinent matter already published, and to special articles based on his personal observations and those of his assistants. Precise experimental work, or systematic field operations of any sort, were beyond his reach. His principal assistants, Prof. G. H. French, Mr. D. W. Coquillett, and Miss Emily A. Smith, were engaged to enable him to share in the work of the United States Entomological Commission, appointed in consequence of destructive outbreaks of the western locust.

Among the varied interests to which the versatile and active mind of Doctor Thomas was devoted in turn the study of ethnology came to dominate, and finally led him to abandon entomology and to recommence his scientific work in a new field at an age when many a man would have been thinking of bringing his career to a conclusion.

Doctor Thomas was twice married, his first wife being Dorothy Adeline Logan, a sister of Gen. John A. Logan, and his second, Viola L. Davis of Youngstown, Pa. Mrs. Thomas and three daughters survive him.

S. A. F.

JAMES ALEXANDER WEST

Mr. James Alexander West, an assistant to the state entomologist of Illinois, died of tuberculosis April 17, 1910, at Ottawa, Illinois, in the thirty-fourth year of his age. Mr. West was educated at the Illinois Wesleyan University, receiving his bachelor's degree there in 1889 and his master's degree in 1904. After a theological course in the Northwestern and Boston universities he preached for two years, and then returned to scientific work in the state entomologist's office and in the University of Illinois, serving as entomological assistant and chief horticultural inspector, and taking at the same time a graduate course in entomology, for which he would have received his doctor's degree at the commencement of 1910 except for the failure of his health last September. Mr. West was a painstaking, thorough and accurate student of entomology, and a faithful, loyal and unselfish gentleman. He was a clear writer, and an unusually acceptable speaker to general audiences. He made friends easily, was highly regarded by his entomological associates, and was rapidly becoming widely and favorably known throughout his state. Although at the very beginning of his scientific career he had already won sufficient recognition and appreciation to bring him last year an appointment as head of the department of entomology in an important state university and agricultural ex-

periment station, an appointment which he declined in order to complete his graduate course. He left several papers on economic subjects in form for publication, including one on the food of the common mole, now in press as a bulletin of the Illinois State Laboratory of Natural History. S. A. F.

Reviews

Chermes of Maine Conifers, by EDITH M. PATCH, Me. Agric. Exp. Sta. Bul. 173, p. 277–308; Fig. 108–146, on 14 plates. March, 1910.

The present paper in an account more or less popular in its nature of all the species of *Chermes* which have been studied by the author as attacking coniferous trees in Maine. The paper treats of seven species, six of which form galls on spruce trees, three being previously described elsewhere as new by Miss Patch. One of these, *C. pinifoliæ* Fitch, also occurs on white pine, as does the seventh species, *C. pinicorticis* Fitch. These two species have been confused under the name of *C. pinicorticis* by writers for the past forty years. *C. pinifoliæ* was described by Fitch more than fifty years ago, but several of the later writers have regarded it as a synonym of *C. pinicorticis*. Recent studies by Miss Patch show them to be distinct, and *C. pinifoliæ* Fitch has therefore been reinstated by Miss Patch. *Chermes* (*Adelges*) *abieticolens* Thomas has for several years been regarded as a synonym of *C. abietis* Linn., and it interests us to learn that it is identical with *C. pinifoliæ* Fitch, and that this species attacks both pine and spruce.

The reason for crediting the species *abietis* to Cholodkovsky instead of Linnæus does not appear to be explained in the paper.

It is a source of convenience to working entomologists to have several species thus treated in a single paper, especially when the literature was widely scattered and inaccessible, as has been the case with the genus *Chermes*. Miss Patch has apparently done some careful work, and should be congratulated on the results of her studies and observations. It now remains for some one to make a more careful and extended investigation of remedies, and this is important because at least two species, *C. abietis* and *C. pinicorticis*, are serious pests of cultivated Norway spruce and white pine trees. It will also be interesting to know how many of the species catalogued from Maine are found in other states.

The drawings and photographs reproduced in the plates are excellent, and of great help in showing the characteristic appearance of the different species of *Chermes* and their galls. W. E. B.

Gypsy and Brown-Tail Moth Suppression, by F. W. RANE, State Forester. St. Forester of Mass. 6th Ann. Rept., Prt. 2, 1909, p. 65–109.

The author states that the larger part of the known infested area is in most cases in a better condition than at the close of the preceding year. The spraying operations have been on a larger scale than ever, high pressures,

long nozzles and a solid stream being marked features. The state forester calls attention to the advisability of experimental work for the purpose of increasing the efficiency of spraying operations. A certain amount of money, at least, might well be expended for this purpose. An appropriation for work against the elm leaf beetle in conjunction with spraying for the gypsy moth is recommended. The financial statement shows that nearly $300,000 were expended by the state for control work. It is stated that extended spraying for a series of years has not resulted in any injuries to vegetation by the poison. The fungous diseases of both the gypsy and brown-tail moths have continued to receive attention. The work with parasites as outlined by Doctor Howard and Mr. Fiske shows that gratifying progress has been made. Every economic entomologist will watch this important phase of the work with the greatest interest.

Parasites of the Gypsy and Brown-Tail Moths Introduced into Massachusetts, by W. F. FISKE, Agent and Expert, Bureau of Entomology, U. S. Department of Agriculture, pp. 1–56, 1910.

This is a well written, comprehensive popular bulletin, giving an excellent summary of the work with parasites. The author discusses the nature of insect parasitism, the natural control of the gypsy moth, parasite introduction in theory and practice, the sequence of parasites and the parasites of the gypsy moth in both Japan and America. There are summarized accounts of some of the more important introduced species, giving valuable biological data in regard to each. The author rightfully emphasizes the value of obtaining an adequate sequence of parasites so as to provide enemies of these two species in their various stages. Admirable tables are given showing the sequence of the various species. There is an excellent discussion of the multiplication and distribution of parasites. The practical man is naturally much interested in knowing when these parasites will become of service. With all the factors in mind, the author has given us in this publication a summarized statement as to the probable dates when various forms will become effective. This table shows that this may be expected of two of the introduced species in 1911, four in 1912, one the following year, another the next and three in 1916. This investigation with parasites is one of the most important phases of the gypsy moth work and should be supported most liberally, since we must ultimately depend in large measure upon some form of natural control.

Spraying for the Codling Moth, Eastern and Western Methods Compared (A preliminary report) by W. E. RUMSEY, W. Va. Agric. Expt. Sta. Bul. 127 : 127–140.

This brief bulletin, printed on good paper and excellently illustrated, gives some very convincing data as to the efficacy of spraying for the codling moth. There is a comparison between the western method of spraying with one application of a coarse spray and high pressure, and the eastern method of four treatments giving a mist spray at medium pressure. The percentages are practically parallel. We regret, in view of our results obtained last year, that the author was unable to make a comparison between one and more applications of a mist spray at medium pressure, since our work showed very lit-

tle gain with three applications over that obtained with one thorough treatment. This was true also in the case of the coarse spray at a high pressure. The average efficiency of one application, be it coarse or fine, at high or low pressure, should be carefully determined for the eastern United States, since it is a matter of great practical importance to our fruit growers, especially if there is liability of injury when large amounts of arsenic are applied to orchard trees.

The Apple Leaf Hopper, *Empoasca mali* LeB., by R. L. WEBSTER, Iowa Agric. Expt. Sta. Bul. 111: 1–32.

This is an extended, well illustrated account. The author states that the most serious injury occurs on young apple trees in the nursery row. The characteristic work of this insect is described, followed by a detailed discussion of control measures, the author favoring spraying and dipping. The more technical matter, such as the synonomy, a detailed account of the life history, follows and is made more complete by an extended bibliography. The arrangement of this bulletin should appeal to the practical fruit grower and be of equal service to the economic entomologist.

Current Notes

Conducted by the Associate Editor

The following appointments to the Division of Entomology of the Department of Agriculture of Canada have been made:

Mr. R. C. Treherne, who has been temporarily engaged on the staff of the Division of Entomology as inspector of imported nursery stock for the browntail moth and who worked for some time with Mr. Wilmon Newell at Baton Rouge, La., and also Mr. G. E. Sanders, formerly assistant in entomology with Prof. S. A. Forbes, Urbana, Ill., have been appointed for field and inspection work. Communications should be addressed to them at the Division of Entomology, Central Experimental Farm, Ottawa, Canada.

Dr. C. Gordon Hewitt, dominion entomologist of Canada, Ottawa, made a trip to the States during June and visited the entomological departments of the agricultural experiment stations at Geneva, N. Y., Cornell University, Ithaca, N. Y., New Haven, Conn., Kingston, R. I., Durham, N. H., Orono, Me., the state entomologists at Albany, N. Y., and Augusta, Me., and the entomological department of Bussey Institution, Harvard University, Forest Hills, Mass. He also inquired into the work of suppressing the gypsy and browntail moths in Connecticut, Rhode Island, Massachusetts, New Hampshire and Maine and spent a week in Boston inspecting the parasitic and field work that is being carried on by the United States Bureau of Entomology and the state of Massachusetts.

According to *Science*, Mr. Robert Newstead, lecturer in economic entomology and parasitology at the Liverpool School of Tropical Medicine, has gone to Malta to investigate the menace to health by the sandfly.

Mr. J. C. Bridwell, instructor in zoölogy and entomology at the Oregon Agricultural College, has resigned to accept a similar position in the University of California.

Dr. Leonard Haseman of Cornell University has been appointed instructor in entomology at the University of Missouri.

The fountain erected in memory of Dr. James Fletcher, late dominion entomologist of Canada, was unveiled at the Experimental Farm, Ottawa, July 19, at 4.30 p. m. Invitations were extended to subscribers to the fund by the Fletcher Memorial Committee of the Ottawa Field Naturalists' Club, and short addresses were delivered by the Hon. Sidney A. Fisher, minister of agriculture; Dr. C. J. S. Bethune, professor of entomology of the Ontario Agricultural College; Dr. William Saunders, director of the Dominion Experimental Farms, and other associates of the late Doctor Fletcher. An appreciative letter was also read from Dr. L. O. Howard, chief of the Bureau of Entomology, Washington, D. C.

The new $40,000 building of the Florida Agricultural Experiment Station is nearing completion and will be occupied sometime during the latter part of the summer. It will provide quarters for all departments of the station. The entomological department will be located on the third floor and will occupy three rooms and a store room. The general laboratory is 20 x 23 feet, with special laboratory and office adjoining, each 12 x 15 feet in size; store room is 7½ x 12 feet.

The new science building of the University of Florida is also nearly finished, and will be occupied before the summer ends. Both buildings will be dedicated some time next fall.

Henry Clay Weeks of Bayside, L. I., a civil engineer who has had charge of a number of elaborate drainage projects for mosquito extermination, died recently at the age of fifty-six years.

Prof. E. D. Sanderson has resigned as entomologist of the New Hampshire Agricultural Experiment Station and accepted a position as dean of the College of Agriculture in the University of West Virginia. This change means a loss to New England, a locality sorely in need of the best economic entomology can offer. Professor Sanderson takes up his new duties at Morgantown September 1. We take this opportunity of extending to him our best wishes in his new field of effort.

Mailed, August 15, 1910.

JOURNAL
OF
ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Vol. 3 | OCTOBER, 1910 | No. 5

THE NATURAL CONTROL OF HETEROCAMPA GUTTIVITTA[1]

By W. F. Fiske and A. F. Burgess, *Melrose Highlands, Mass.*

In the April issue of the Journal, page 16, appeared an article by Mr. Burgess concerning the abundance of *Calosoma frigidum* in New Hampshire during the previous summer. Data were given showing that in areas where the beetle larvæ had finished feeding 78 per cent. of the pupæ of *Heterocampa guttivitta* had been destroyed, and where the larvæ were about one-half grown 54 per cent. of the pupæ of this moth had been killed at the time of the last examination, August 21–25, 1909. In view of these facts it seemed desirable to continue the observations this summer, in order to determine whether the work of this beneficial beetle, or of any parasitic insects, might be bringing about the natural control of *Heterocampa*. Accordingly,it was planned to make several trips to the region visited last year in the vicinity of North Conway. Mr. Harry S. Smith spent from July 10 to July 13 in this section making observations and collections on Mount Kearsarge, White Horse Cliff and various other ranges in the vicinity. Localities were visited where the trees had been very slightly to completely denuded by the caterpillars during the previous year, but Mr. Smith was able to find only an occasional larva of *Heterocampa* and very few specimens of *Calosoma frigidum*.

An examination of the earth showed that a very large percentage of the *Heterocampa* pupæ had been eaten by *Calosoma*, and that only a few moths had emerged in a normal manner. In spite of this, however, numerous eggs of the moth were found deposited singly on the leaves of beech and other trees. Mr. Smith noticed that most of these

[1] Occasional contribution from the Gypsy Moth Parasite Laboratory No. VI.

eggs had apparently hatched, but, on more careful examination he found that nearly every one had been attacked by a minute egg parasite. In a beech grove on the southern slope of Mount Kearsarge a count of 56 eggs of *Heterocampa* gave the following results:

Number containing prepupæ of parasite	35
Number from which parasites had emerged.........	14
Number from which caterpillars had hatched.......	2
Number of eggs apparently dead..................	5

This shows that the percentage of parasitism in this case equaled 87.5. Only one pupa was found in each parasitized egg, and no larvæ of the parasites were observed. This was probably due to the fact that the observations were made a little too late in the season to secure the early stages of the egg parasite.

Mr. Smith brought specimens to the laboratory at Melrose Highlands from which were reared a considerable number of egg parasites. Examples have been submitted to Mr. C. T. Brues of the Bussey Institution of Harvard University, who has identified them as very similar, if not identical, with *Telenomus graptæ* Howard.

On July 24 Mr. Fiske, accompanied by Mr. Reginald Wooldridge, of this laboratory, visited the region near White Horse Cliff where observations were made by Mr. Smith about two weeks previous. No caterpillars or beetles were found and conditions were much the same as those reported by Mr. Smith. Evidence of the work which had been done the previous year by *Calosoma* was very easy to obtain, and eggs of *Heterocampa* which had been parasitized by *Telenomus* were present on the foliage. Out of eighty eggs examined by Mr. Fiske, not one was found from which a parasite had not emerged, or in which a dead larva or pupa of a parasite was not present. Not one of the eggs had hatched and not a single caterpillar in any stage was observed.

Mr. Wooldridge continued his investigations at North Conway, West Ossipee, and Crawford Notch, but found very few *Heterocampa* larvæ, and only an occasional beetle. At Mount Cramer, North Conway, an examination of 29 eggs showed that 23 had contained parasites, and on Mount Kearsarge 29 eggs out of 33 examined in one locality, and 14 out of 16 examined in another had been destroyed by *Telenomus*.

In order to secure any further data that might be obtained a final examination of this territory was made by Mr. Burgess and Mr. C. W. Collins. The region which was badly infested near White Horse Cliff during the previous year was visited August 20. No evidence of the feeding of *Heterocampa* could be noted, but many of the trees showed

injury from the serious defoliation sustained the previous year. Examinations of the fallen leaves were made in order to determine the percentage of *Heterocampa* larvæ that had been destroyed the previous season, as well as to find out the average number of moths that emerged sucessfully. Mr. Collins continued the work and visited several localities near North Conway, Intervale, and Tamworth where the caterpillars had been abundant during the previous year, making counts of the pupæ found in badly infested areas and in sections nearby. The following table gives the summary of the counts made by him in the different localities and shows the number of pupæ destroyed by different natural enemies, as well as the number of moths which emerged in a normal manner. Twenty-seven out of 28 eggs examined by Mr. Collins were found to have been destroyed by *Telenomus*.

WORK OF HETEROCAMPA ENEMIES.

Areas examined.	Square feet.	Locality.	Pupae Destroyed by Calosoma	Pupae Destroyed by parasites	Pupae dead.	Moths emerged.
13	28	White Horse Cliff	62	...	...	2
10	19	Mount Kearsarge	35	2	...	6
5	13	Mount Hurricane	19	...	...	5
16	26	Mount Surprise	106	...	2	17
8	16	Tamworth, N. H.	15	...	2	1
11	19	Tamworth, N. H.	75	...	7	3
63	120		312	2	11	34

By computing the totals in this table it will be found that 87 per cent. of the *Heterocampa* pupæ in the region were destroyed by the larvæ of *frigidum* during August, 1909, which is slightly higher than the figures secured last summer, and 3.66 per cent. died from the attack of parasites or from other causes. The small percentage of moths—9.33—which emerged during the spring would undoubtedly have caused some injury to the foliage had it not been for the intervention of the tiny egg parasite already mentioned, although it is fair to assume that the caterpillars would have been seriously decimated by the swarm of *frigidum* beetles which must have developed from the large number of larvæ of the previous year. If we assume that the sexes of the moths were evenly divided, it is apparent that on the average only one female was developed from 21 pupæ of the previous year. This enormous reduction which was caused by the work of *Calosoma* is, of course, of great importance, still it must be remembered that each *Heterocampa* female is capable of depositing 500 or more eggs according to observations made by Miss Patch on this insect in Maine. It, therefore, is clear that the primary factor in bringing *Heterocampa* under natural control, aside from the work of *Calosoma frigidum* was due to the little egg parasite.

The observations made failed to show that Tachinid parasites played any important part in checking *Heterocampa*. A single caterpillar was found in 1909 which contained a large number of small maggots of an unknown species. This is the only instance where Tachinid parasitism was noted. Owing to the careful examination of a considerable area of leaves and soil it is inconceivable that the puparia of parasitic flies could have been overlooked if they had occurred in any great abundance.

Hymenopterous parasites on the immature caterpillars appeared to be lacking, or nearly so. None were found directly associated with *Heterocampa*, but cocoons of *Limnerium* similar to, and perhaps the same as the species which has been determined as *Limnerium clisiocampæ* Ashmead, were found in small numbers on abundantly infested trees in 1909. *Pimpla pedalis* and *Ichneumon* sp. were sufficiently abundant as parasites on pupæ in 1909 to cause considerable mortality, but since the pupæ were particularly liable to destruction by the larvæ of *Calosoma*, the parasites in turn suffered to a great extent and their utility was materially reduced.

The same scarcity of *Heterocampa* which obtained in New Hampshire this summer was also noted in Maine. During 1909 this insect was abundant to a greater or less extent throughout southwestern Maine. Practically all of the towns west of Boothbay, Augusta, Winslow, Clinton, Skowhegan and south of Madison, Stark, Farmington, and Bethel were infested to a greater or less extent and in many sections large areas were completely defoliated.

On August 13 Mr. Burgess visited a number of towns in the southwestern part of the state, but not a single larva of *Heterocampa* was seen and although diligent inquiry was made of many persons who travel to a greater or less extent over the territory which was infested the previous year, not a single instance could be found to indicate that *Heterocampa* was at all abundant or that any trees had been stripped by it this summer. In company with Capt. E. E. Philbrook and Mr. E. M. Sadler a visit was made to Mount Agamenticus, and during this trip a region was passed through which had been defoliated by *Heterocampa* in the summer of 1909. The trees showed no evidence of feeding by this species, although some of the oaks had been eaten by other caterpillars. Mr. A. M. G. Soule, one of the gypsy moth inspectors of the Maine Department of Agriculture, stated that he had seen a few *Heterocampa* larvæ in the region near Mount Agamenticus this summer, but not in sufficient numbers to do any damage or cause defoliation. He reported *Calosoma frigidum* as abundant last year and as occurring in larger numbers this summer.

A question which naturally arises is what has become of the large

numbers of beetles which were developed from the unusual abundance of larvæ in 1909. It is probable that in New Hampshire these beetles migrated to localities where other food was available and undoubtedly many of the native caterpillars which occur every year in greater or less numbers were destroyed by them. The investigations at the gypsy moth parasite laboratory have shown that beetles of this genus are able to survive for a long time without food and that in case the food supply is scanty only a small number of eggs are laid. This probably indicates what has happened in the *Heterocampa* regions in New Hampshire, so that on account of the relative scarcity of the food supply it is probable that the reproduction of this beneficial species has been greatly curtailed. Interesting information in this respect has been secured from the men engaged in the gypsy moth work in Maine. Capt. Philbrook states that during the summer his men continually reported large numbers of *Calosoma frigidum* in sections infested with the gypsy and brown-tail moths. The species had been found in previous years, but only in limited numbers compared with this year and it is apparent that many had migrated from the *Heterocampa* infested region in search of food. Mr. Soule states that on the Chase lot near the foot of Mount Agamenticus about three *frigidum* beetles were found under each burlap while on the Fitzgerald lot nearby the species was even more abundant. In several instances this beetle has become so abundant in southwestern Maine during the past summer as to cause complaint or inquiry by citizens. During June one of the summer residents at Cape Elizabeth, Me. sent to the laboratory specimens of this insect and a statement that they were found crawling on his grounds, trees and buildings in large numbers and were causing some alarm among the residents owing to the belief that they might be of a poisonous nature. Early in July a letter was received from Miss Harriet S. Gilbert from Prout's Neck, Me., together with a specimen of the beetle. In it she states that "for the past three weeks they have been all over our house, inside and out," and asked if they were beneficial or injurious, and if the latter what measures should be taken to destroy them. The last two instances show that there has been an enormous increase in this species in southwestern Maine, and probably a general migration from *Heterocampa* districts to gypsy and brown-tail moth regions, as it has been observed that this species is capable of flight, although no accurate data are at hand to show the distance to which they may be dispersed in this way.

From the habits and life history of *Calosoma frigidum* and *Telenomus graptæ* it appears that they are admirably suited as a natural means of controlling *Heterocampa*. What conditions could have brought

about the remarkable increase of the latter species during the past few years is difficult to conjecture, but there can be no question of the effective manner in which they have supplemented each other's work and reduced the numbers of *Heterocampa* to a minimum. This same principle, namely, the sequence of natural enemies working together in harmony on different stages of the host is what is hoped may be the final result of the introduction of parasites and natural enemies of the gypsy and brown-tail moths which is now being attempted in Massachusetts.

FUMIGATION BOX MATERIALS

By W. E. Hinds, *Entomologist to Alabama Experiment Station*

In connection with investigations relating to fumigation, the writer, assisted by Mr. W. F. Turner, has had occasion to test a variety of materials such as are commonly used in fumigation boxes or tents, to determine their comparative resistance to the transmission of air. The economic entomologist is frequently called upon to recommend materials and types of construction for fumigation outfits. This paper is offered in the hope that the experiments reported may be valuable for their suggestions in this direction. Naturally the material with which fumigation treatment is to be made is one of the first factors to be considered.

Our work thus far has been principally with carbon di-sulfid and with this substance, the problem of constructing a gas-tight container is complicated especially by its chemical properties. One volume of carbon di-sulfid liquid is supposed to produce 375 volumes of vapor. Naturally therefore, in a closed container, the pressure of gas from the evaporating liquid is a considerable factor. In an experiment to determine the amount of this pressure, a two-necked Wolff bottle was used as the container. In one opening a mercury manometer was tightly fitted through a rubber stopper. Through the other neck, a small quantity of liquid carbon di-sulfid was introduced and the opening then closed tightly with a rubber stopper coated with glycerine. In this tight apparatus, the pressure produced by the evaporation of the liquid at a room temperature of 60 degrees F., amounted in a few minutes to more than 2.5 pounds per square inch, or more than .15 of an atmosphere. At higher temperatures, the pressure would be very much greater than this. In all ordinary fumigation chambers, the leakage has been found to be so great that the evaporation of liquid carbon di-sulfid produces no increase of pressure even with a

water manometer, which is far more sensitive than the mercury instrument.

Furthermore, carbon di-sulfid is one of the best chemical solvents known for waxes, varnishes, oils, etc., such as might be commonly employed in rendering boxes gas-tight for hydrocyanic gas fumigation. Paint, varnish, putty, paraffin, tarred paper, etc., are very soluble in carbon di-sulfid liquid or gas and cannot, therefore, be used as finish-coats where this material is the fumigant.

One of our first objects was to find some material which was insoluble in carbon di-sulfid liquid or vapor. Glycerine proved to be an effective sealing agent between ground glass surfaces, as in stop-cocks, stoppers, or under bell jars, where the pressure produced by the gas would not be sufficient to lift or separate the surfaces. Animal glue appears to be entirely insoluble in di-sulfid and, at first thought, it appeared that this material might be satisfactory for painting over woodwork, sealing joints, cracks, etc., in fumigation boxes. A difficulty soon appeared in the case of glue, however, as external coats are likely to crack and peel, thus rendering them practically worthless. Water glass is another material which, when dry, appears to be resistant to the di-sulfid vapor. But water glass cracks even worse than does glue when applied to wood surfaces. Cracking may be reduced to a considerable extent by adding about 10 or 15 per cent. of glycerine to the water glass, but even then it is unsatisfactory.

As a general rule for fumigation tents to be used with hydrocyanic acid gas, about 8 ounce duck is employed. In most cases, this is not treated with any filling solution to reduce the porosity of the cloth and recent reports of experiments in tent fumigation indicate that leakage is so large a factor that fumigation is unreliable if there be any considerable wind blowing. Double and triple filled duck can be used and are improvements over the ordinary grade.

For fumigation boxes with either hydrocyanic acid gas or carbon di-sulfid, the materials most commonly used are probably matched flooring laid double with paper lining between. The paper is usually well overlapped but the edges not tightly sealed together. In fitting doors and movable windows, various grades of felt or of folded cloth are commonly employed for the bearing surfaces.

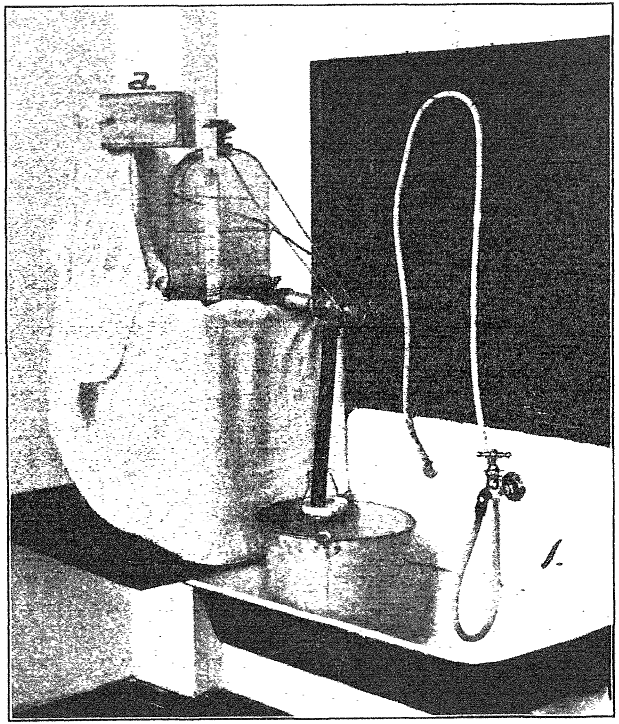
In our experiments, most of the tests have been made with various weights and qualities of duck but other materials have been included and some of these have been treated in various ways. Few people have any definite conception of the real difficulty of constructing an absolutely air-tight fumigation box. Most woods are decidedly porous and especially so if they are cross-grained. In an attempt to construct a small air-tight box, in which an aneroid barometer might be placed

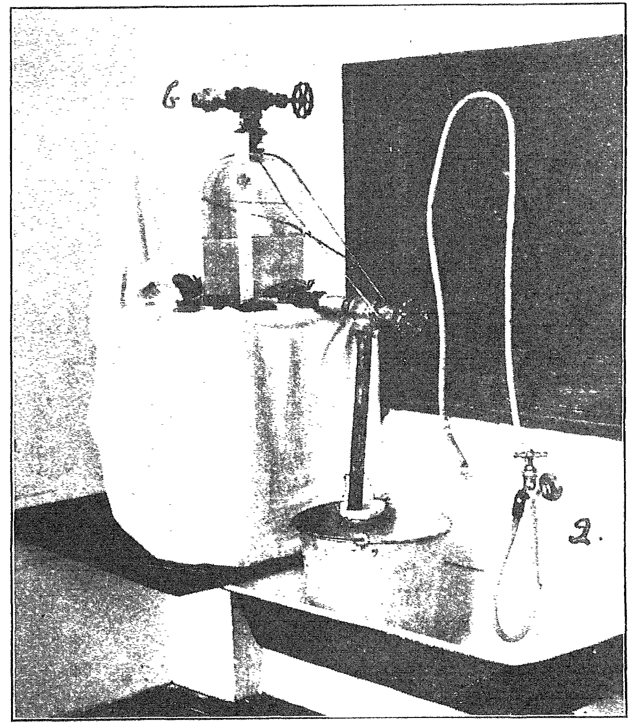
to give measurements of pressure when connected with various experiments, it was found very difficult to secure absolute tightness even when the interior was thoroughly coated with glue and the exterior likewise covered with paraffin.

The apparatus used in making the tests here reported was designed to give comparative results rather than an absolute measurement of the porosity of a given area in the materials tested. The idea involved is certainly not new and has, I think, been employed by Dr. A. W. Morrill and Mr. W. W. Yothers in tests of tent materials in white fly investigations in Florida. The accompanying illustrations (Plate 25, figures 1 and 2) give a fair idea of the apparatus used. A large aspirator bottle was elevated to such a height that a column of water varying from 17 to 27 inches in height, could be utilized. Steam valves arranged to make air-tight connections through rubber stoppers were fitted to both inlet and outlet openings. The outlet pipe opened under water to prevent air being drawn back into the apparatus when a partial vacuum was produced. This was arranged, however, so as to overflow and not affect the uniformity of pressure at the outlet. The samples tested were placed in the union coupling at the upper left hand corner of the apparatus, where they were clamped between two metal surfaces. With the upper valve closed, and the lower valve open, water could escape until equilibrium was established. The height of the water surface in the bottle was then read upon the scale and the upper valve quickly opened. The amount of water which then ran out in a given period of time depended entirely upon the amount of air which could enter through the material placed in the union. If the material were air tight, no water could escape. If the material were very porous, water would escape rapidly. In the comparison of materials, the percentage of porosity is based upon the ratio of the inlet of air through the material under test as compared with the inlet of air through the apparatus with no material enclosed. That is, with the union joint entirely free and open, the percentage was taken as 100. The area of the samples as used was actually .44 of a square inch, but this area does not affect the comparison made.

In the table given below, the materials have been arranged in order of the increasing percentage of porosity ranging from those which were air tight to those which retarded the inlet of air but very little.

Plate 25





Apparatus for testing the porosity of cloths, etc., for fumigation outfits; 1a Aneroid barometer box; 2b Union coupling in which samples were placed for test (Original).

Most of the samples of duck used were obtained from Hettrick Bros., Toledo, Ohio. In reference to the samples of brown waterproofed ducks, Nos. 1, 2, 3, 8, 16 and 26, it appears that the lighter weights are fully as satisfactory in their gas-proof qualities and are less injured by severe handling than are the heavy weights. The coating on this material was but slightly soluble in liquid di-sulfid and would probably

COMPARATIVE AIR POROSITY OF FUMIGATION MATERIALS

Sample No.	Material and Treatment.	Percentage of leakage.
1	7 oz. duck, Hettrick Bros., brown waterproofed	0
2	8 oz. duck, " " " "	0
3	10 oz. duck, " " " "	0
4	Good grade bond letter paper, coated with water glass	0
5	Extra heavy ledger paper, untreated	0
6	Rubberoid roofing paper, two ply	0
7	Light weight bond letter paper	1.8
8	7 oz. waterproofed duck, severely crumpled and rubbed for one minute	4.2
9	10 oz. duck, treated with one coat of glue containing some glycerine and water glass	7.1
10	10 oz. duck, with one coat of glue with glycerine only	9.5
11	10 oz. duck, with one coat of glue with some glycerine and one-half as much water glass	12.0
12	Plaster of Paris, sheet 1-10 to 1-12 inch thick, dry	19.0
13	Plaster of Paris, sheet 1-10 to 1-12 inch thick coated with vaseline	28.6
14	10 oz. duck, with one coat of water glass, thinned with glycerine each side	33.3
15	10 oz. duck, with two coats water glass, as above on one side	33.3
16	8 oz. brown waterproofed duck severely rubbed one minute	38.0
17	20 oz. duck, untreated	40.0
18	14 oz. duck, untreated	42.9
19	10 oz. duck, with one coat water glass and no glycerine on one side	47.8
20	10 oz. duck, with one coat water glass, thinned with glycerine on one side	52.4
21	10 oz. duck, one coat water glass each side	52.4
22	14 oz. paraffined duck	61.9
23	18 oz. duck, untreated	67.6
24	16 oz. paraffined duck	67.9
25	16 oz. duck, untreated	76.2
26	10 oz. brown waterproofed duck, severely rubbed	76.2
27	Canoe duck, untreated	78.6
28	8 oz. army duck	81.0
29	16 oz. paraffined duck, severely rubbed	81.0
30	10 oz. duck, untreated	85.7
31	Heavy gray felt, very spongy (weight 256)	90.5
32	7 oz. army duck	95.2
33	Thin cotton cloth, treated with "Preservo," (a waterproofing solution)	95.2
34	Green felt, (piano-action felt) somewhat compressed	95.2
35	Soft gray felt, (weight 285)	95.2
36	Gray felt, (weight 181)	95.2
37	Thin red felt	95.2
38	Apparatus entirely open	100.0

prove resistant for a long time to the vapor. Paraffined duck samples 22, 24 and 29, while thoroughly water-proof, contained many comparatively large air holes, which place them all high in the percentage of leakage. They were in fact even more porous than untreated samples of the same weight. The addition of a small percentage of glycerine in solutions of glue rendered the glue much less brittle, less liable to cracking and slightly less porous than where glycerine was omitted. The difficulty with all glue-coated samples seemed to be that small airholes were formed in the coating, even on smooth surfaces, which opened when the glue dried and hardened, permitting the passage of air even in cases where both sides of the cloth were treated.

It is noticeable that all the samples of felt are among the most porous of the materials tested. In fact they have very little resistance

to air passage if they are at all soft and springy. It is equally noticeable that the paper samples transmitted very little, if any, air.

These results suggest that in the construction of fumigation boxes, we should depend for gas-tightness upon heavy paper, with the edges and overlappings securely sealed, as by gluing, more than upon the quality of lumber, the tightness of the joints, or even a finishing coat, with any material which we have yet tested for resistance to carbon di-sulfid vapor. With hydrocyanic gas, there will be less difficulty because of its lack of the solvent power possessed by the carbon di-sulfid.

APHELINUS DIASPIDIS HOWARD

By H. J. Quayle

This chalcid (*Aphelinus diaspidis* Howard) is by far the commonest parasite of the red or orange scale (*Chrysomphalus aurantii* Mask.) in California; in fact, it is the only one of any economic significance. It may be found throughout the citrus belt of southern California, and, while in some places on trees badly infested with the red scale, it may seem rather common, it cannot be counted a very important control factor, since the maximum parasitization found thus far has not exceeded five per cent.

This insect is commonly spoken of as an internal parasite, yet strictly speaking, so far as the scale insect itself is concerned, it is an external parasite. That is, while it may be under the scale covering, it is not within the body of the scale itself like those of the Soft Brown or Hemispherical Scales, or the various parasites that are entirely surrounded by the body tissues of their host.

The *egg* is yellowish white in color, ovate in form, measuring .16 mm. long and .96 mm. wide. There is a conspicuous micropyle projecting from the narrower end and also attached to this a short stalk that is doubled back on itself. The chorion is smooth, with spherical granular bodies showing through with transmitted light.

The *larva* when full grown appears as a more or less structureless top-shaped globule, measuring, when segments are normally extended, .75 mm. long and .5 mm. wide. It tapers considerably more toward the posterior end, and there is a slight difference between the dorsal and ventral surfaces. The distance between the upper and lower surfaces is a little less than the width of the body so that there is some indication of flatness. The color is glossy white, with the food in the digestive tract showing distinctly yellow, oval in shape and measuring about one half the dimensions of the larvæ itself. There are 14 indistinct segments including the button at the tip. The head end is

broadly rounded, contrary to what might be expected, with the first segment disc shaped and firmer than the others, with the small mouth opening in the center. This mouth opening is about 20 μ in diameter and there are two chitinous spines projecting toward its center in front. These spines are 18 μ in length and 15 μ wide at the base where the muscle attachment occurs. From near the base they suddenly narrow into a sharp pointed spine which is chitinous at tip and brown in color. These are used for piercing the outer wall of the scale and for holding in place while the fluids are sucked from the body.

The *pupa* is dark yellow in color, with ocelli and eyes reddish brown and a similar pigment extending around the anterior margin, and to a less extent about the posterior margin, of the head. Length .75 mm., width .375 mm. The adult appendages, enclosed in their sheaths, lie close to the body on the ventral side. Always accompanying the pupa are from 6 to 10 black or dark brown torpedo like bodies .125 mm. long and .055 mm. broad, which are evacuations from the digestive tract and are expelled by the larva preliminary to pupation.

The duration of the egg stage is from 4 to 5 days, of the larval stage 12 to 16 days and of the pupal stage 8 to 10 days. The adult[1], under nearly normal conditions, usually died in 4 or 5 days.

This parasite does not always emerge through an exit hole in the scale, but very commonly simply pushes its way out from under the scale. The scale covering seems to be loosened from the surface in most cases so that this means of emergence is comparatively easy. This is further brought about by the movement of the parasite, and also because of the fact that the scale covering is always separated from the insect and has a chance to loosen before the parasite is mature. In case, however, the scale covering is held securely to its resting surface the parasite eats out an irregular, rectangular usually, hole in the scale covering just beyond the molted skin, in the case of female scales, and at the posterior third in the case of male scales. The parasite almost invariably is lying on its back as a pupa. Not infrequently two pupæ are found under one scale and one case has been observed where there were three.

The egg is deposited under the scale covering, but either on the upper or lower side of the insect itself, most commonly on the lower. It is not inserted within the body of the scale insect. Preliminary to oviposition a thorough examination is made of the scale by alternately tapping with the antennæ from the center of the scale to the periphery. Upon reaching the edge of the scale a rapid backward movement is made at the same time turning slightly around so that the entire

[1] The adult of this insect has been described by Howard in the Ann. Rep. U. S. D. A. for 1880.

surface is explored by the antennæ in from five to eight backward and forward movements in a remarkably short time. This procedure may occur with but one scale before the ovipositor is inserted, and again, two dozen or more may be gone over without finding a suitable scale for oviposition. But the parasite does not rely alone on the exploration with the antennæ, for the ovipositor may be inserted many times without any eggs being deposited. Insertion with the ovipositor may occur with the insect beneath in various conditions, and not infrequently it is dead and shriveled up. But exploration by the ovipositor is the final reliance for the placing of the egg.

A specific case will serve to illustrate the behavior during oviposition. Parasite inserted ovipositor and laid egg in scale No. 1 occupying five minutes. One insertion was made in each of three other scales occupying from 1 to 3 minutes each. No eggs deposited. In scale No. 5 ovipositor inserted 11 times and remaining in scale as follows: 1 min.; 3-4 min.; 1 min.; 1 3-4 min.; 1 min.; 1 min.; 1 1-4 min.; 1 min.; 3-4 min.; 1 1-2 min.; 6 3-4 min. Scale lifted and but one egg deposited, this undoubtedly at last insertion.

Eggs may be deposited under scales of various stages as follows: Female between 1st and 2nd moult and between 2nd moult and egg laying. Male after 1st moult, propupa and pupa. In no case has a larva of the parasite been seen with a scale during the moulting period or during the egg-laying period. The scale during these periods is very different than at other times. The body wall is hard and glassy, while the contents are more fluid and the insect adheres firmly to the scale covering. Between the moults the body wall is flexible, is not so distended by the body fluids, and the scale covering very readily separates from the insect itself. This last point accounts for the readiness with which the covering is lifted in many cases to allow the escape of the parasite.

In the June number of this Journal Dr. Howard[1] has an interesting article on the feeding habits of certain of these chalcid parasites. Observations are recorded upon four species that feed at the puncture holes made by the ovipositor. In the case of *A. diaspidis* only two or three times has any indication of this habit been noticed and then it was not certain that they either fed at the puncture hole or sealed it. At any rate, this cannot be counted a common habit with this species, for many hundreds of insertions have been observed during the past three summers. Observations have been made, however, on this species feeding on a droplet of honey dew, and also some evidence that they feed on plant tissue. They have been observed many times

[1] On the Habit with certain Chalcidoidea of Feeding at the Puncture Holes made by the Ovipositor. By L. O. Howard.

lying prone upon the fruit itself working the mandibles and going through all the movements of feeding. But if the surface tissue was actually penetrated it was too small to be observed with a low power lens. This habit of feeding on plant tissue is very common with the Soft Brown Scale (*Coccus hesperidum*) parasite (*Coccophagus lecanii*) and here very distinct feeding marks are left in the form of narrow strips of the surface tissue gouged out.

In a considerable number of specimens collected from various places during the past three seasons no males have yet been taken. That this species may reproduce parthenogenetically there is no doubt, for a female just emerging was placed in a glass vial for two or three hours and upon being liberated on a scale infested orange there was immediately deposited beneath a scale an egg, which later hatched.

THE ORANGE TORTRIX

(*Tortrix citrana* Fernald)

By H. J. Quayle, *Southern California Laboratory, Whittier*

This insect was first described in 1889 by Professor C. H. Fernald[1] from specimens bred from oranges from southern California by Mr. D. W. Coquillett.[2] Complaints of it have occurred from time to time since, but with the exception of occasional years, it has not occurred in sufficient numbers to attract much attention. According to Coquillett, considerable inquiry was made about the insect in 1894[2] and also again in 1898.[3]

During the season of 1909–10 this insect was the cause of no little concern in certain sections of the southern California citrus belt. It seemed to be most abundant in Los Angeles County from Glendale to Pomona, very few being seen further east in the Riverside-Redlands district. In some of the packing houses during the early part of the shipping season the amount of wormy fruit ran between 5 and 10%.

Coquillett states that "ordinarily it lives in a rolled or folded leaf, upon which it feeds, but it also has the habit of burrowing into the green oranges." This latter habit of burrowing into the fruit really seems to be the most common. Very little evidence of rolled or folded leaves was noticed in the infested groves and the worms kept under observation in the laboratory seemed to attack the fruit in preference to the leaves.

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[1] Ent. Amer. Vol. V p. 18, 1889.

[2] Bull. 32, Div. Ent., U. S. D. A., p. 24, 1894.

[3] Bull. 18, New Series, Div. Ent. U. S. D. A., p. 99, 1898.

This insect appears to attack a wide range of food plants aside from the orange. Coquillett (*loc. cit.*) states that it occurs on apricot, willow, oak (*Quercus agrifolia*), wild walnut, (*Juglans californica*) and golden rod (*Solidago californica*). On July 24th specimens of larvæ were received from Mr. I. J. Condit of San Luis Obispo which were attacking green house plants. Moths were reared from these and submitted to Dr. L. O. Howard at Washington and were identified by Mr. August Busck as *Tortrix citrana* Fernald. Mr. Condit states that they have been infesting various green house plants for several years, but have not spread out of doors except to some geraniums close by, and to various plants in the lath house. The green house plants listed are: "Wandering Jew, rose, seedling Acacias, seedling Eucalyptus, *Asparagus sprengeri* and *A. plumosus*, lavender, Jerusalem cherry, Pentas, Cineraria, Lantana, *Coix lachryma*, Begonia and ferns of various species. Pelargoniums were especially subject to attack and the larvæ seem to work into the tips and branches of these plants similar to a borer. Commonly they work in folds of leaves tied together by means of silk threads."

The injury to oranges is due to the burrows made in the fruit and usually these go no further than just through the rind. There is considerable variation in the character of the burrows, both as regards size and the depth they go into the fruit. Of course such fruit is classed as culls, and the holes are frequently the source of infection for decay following blue mold, navel end rot, and wither tip fungus. The burrows in the fruit also cause it to drop prematurely, especially if the fruit is still small, so that all of the injury chargeable to this insect is not accounted for in the packing house alone.

The eggs are laid on the leaves, either the upper or lower surface, but more usually on the lower, and also on the fruit. They are laid in masses of from 10 to 35, overlapping one another like shingles. An individual egg is cream color, measures about .75 mm in diameter, disc shaped, slightly convex on upper surface, and with a distinctly marked hexagonal network discernable with hand lens. Two or three of these masses may be laid by a single moth so that the total number of eggs may vary from 25 or 30 to 70 or 80. At the end of six days the two black eye spots of the developing larvae are visible and hatching occurs six days later.

The young larvæ are active and wriggle quickly away on being disturbed. A considerable amount of web is spun and the portion of the orange entered is sometimes covered with a thin network of silk. Larvæ in the insectary chose to enter the orange on the under side where it was resting on the surface. One entered along side a cell which had been attached by paraffin to the fruit. In the field the most

usual place of entry is where two oranges are in contact or an orange and leaf are in contact.

The full grown larva is about ½ inch long. The color varies from greenish white to dark gray, with broken irregular stripes more distinct in the darker specimens. During the growing period of the larva it remains almost continuously within the fruit, but upon reaching maturity it wanders about over the cage at night. During the day it is always found in its burrow. This traveling about off the fruit is no doubt for the purpose of finding a suitable place for pupation. In case no favorable location is found it will pupate within its burrow, first making a slight irregular cocoon. Pupation within the burrow is in fact, very common, though other places may be selected if available. The total length of the larval life is from 55 to 60 days and the pupal period from 9 to 12 days in midsummer.

The number of broods in a season is not very well defined and there is more or less overlapping. There does appear, however, to be a period in the spring when the moths are abundant, and again in the early fall. Moths were common in May and the first part of June and practically none seen in July and August. Moths appear again in September and possibly also again about December. Judging from the appearance of the worms and of the moths there is probably three generations, or two with a partial third generation.

Two species of Braconids (species not yet determined) have been reared from the larva. As for control measures, spraying with an arsenical has been suggested, but the worms would have to become more abundant than they have thus far to make this practical. The most feasible measure seems to be the picking up and destroying of dropped fruit in the field, while the larva is still within its burrow, and also the destruction of the wormy culls as they are sorted out in the packing house.

PLANT LOUSE NOTES, FAMILY APHIDIDÆ

(Continued), Plate 26

By C. P. Gillette

Aphidini

Aphis salicicola Thos., Figs. 1 and 2. Taken at Geneva, Albany, Webster and Woods Holl, on willow. I also have specimens from Massachusetts taken on willow by Dr. T. H. Morgan.

The long cylindrical cornicles, the single row of about 7 sensoria on third joint of antenna, and the very short second fork of the cubital vein seem to be the important distinguishing characters of this species.

Aphis sorbi Kalt., Figs. 3, 4 and 5. Taken at Webster, Amherst, Chicago, Geneva, Hood River and Portland, Ore., on apple. At Geneva and Webster this species was very abundant, rolling the leaves in a manner similar to the work of *A. pomi*. Prof. E. P. Taylor sent me this species from a few trees near Grand Junction, Colo., in 1907, which is the only record for this state.

In Bulletin 133 of the Colo. Experiment Station I referred to this louse as *A. pyri* Boyer, and am not now sure but it is Boyer's species, but a larger number of specimens for comparison have led me to think that it is *sorbi* of Kaltenbach, though the antennæ of the apterous louse are but slightly shorter than the body, and in the alate form they are somewhat longer, and the cornicles of the apterous form are very stout and tapering towards the free end as shown in Fig. 5.

Aphis ripariæ Oest., (?) Figs. 6 and 7. Very abundant on wild grape at Fort Lee, Washington, and Webster, on leaves, tendrils and tender new growths of the vine. This may be the *vitis* of Scopoli.

Aphis asclepiadis Fitch., Figs. 8 and 9. Taken at Chicago, Portland, Mich., Geneva, and Webster on *Asclepias* sp., and at Detroit on dogbane, *Apocynum.* sp. We have taken this species in Colorado at Fort Collins. The reference by Cowen in Bull. 31 of this station was an error.

Aphis pomi De G., Figs. 10 and 11. Taken on apple trees at Chicago, Portland, Lansing, Detroit, Albany, Geneva, Webster, New York City, Portland, Ore., and Hood River, Ore. This is an abundant species wherever the apple is grown in Colorado.

Aphis gossypii Glover, Figs. 12 and 13. In Chicago, abundant on *Philadelphus coronarius* and *Carduus arvensis* (Canada thistle); in Detroit on *Pyrus cornaria*, a few thrifty colonies, and at Central Park, New York City, on *Bursa b. pastoris*. Abundant on the eastern slope in Colorado where melons, cucumbers, squashes and cantaloupes are grown, but unknown upon the western slope.

Aphis spriæella Schouteden, Figs. 14 and 15. What I have taken to be this species was a very common louse upon bridal wreath, *Spiræa prunifolia*. Taken at Lansing (very abundant), Geneva, Detroit, Albany, New York City, Washington, Springfield, Webster, and Woods Holl. In general appearance resembling closely a small *A. pomi*. Was common one year, 1907, on spiræ on the campus of the Agricultural College at Fort Collins, but has not been seen in the state since. The antenna is hardly distinguishable from pomi except in size.

Aphis cardui L., Figs. 16 and 17. Taken on thistle, *Carduus* sp. at Geneva and very abundant about Portland and Hood River, Ore., and at Kansas City, Mo.

Aphis cephalanthi Thos. From button-bush, *Cephalanthus occidentalis,* at Webster, Mass., Figs. 18 and 19.

Aphis sambuci L., Figs. 20 and 21. What seems to be the typical form of this species was taken by Mr. Bragg at Webster, Mass., on *Sambucus* sp.

Aphis cerasifolii Fitch, Figs. 22 and 23. Taken at Webster and Geneva, where it was very abundant on the eastern choke-cherry, *Prunus virginiana.* This is a very common louse, curling the terminal leaves on limbs and sprouts of *Prunus pennsylvanica* wherever I have found this cherry growing in Colorado to an altitude of 8,000 feet.

Aphis bakeri Cowen. Taken at Corvallis and Portland, Ore., on red clover. We have taken this species from red clover or apple about Fort Collins, Denver, Rocky Ford, Canon City, Delta, Paonia, and Grand Junction in Colorado. Figs. 24 and 25.

Aphis brassicæ L. Taken at Corvallis, Ore., only, on rape. A very common species on both east and west slopes in Colorado where it is a serious pest on cabbage, cauliflower and rape. Figs. 26 and 27.

Aphis maidi-radicis Forbes. At Webster, on corn and at Washington on ox-eye daisy, *Chrysanthemum leucanthemum.* About Fort Collins this is a fairly common species on corn roots. Have also taken it on roots of *Helianthus* and on rhubarb. Figs. 28 and 29.

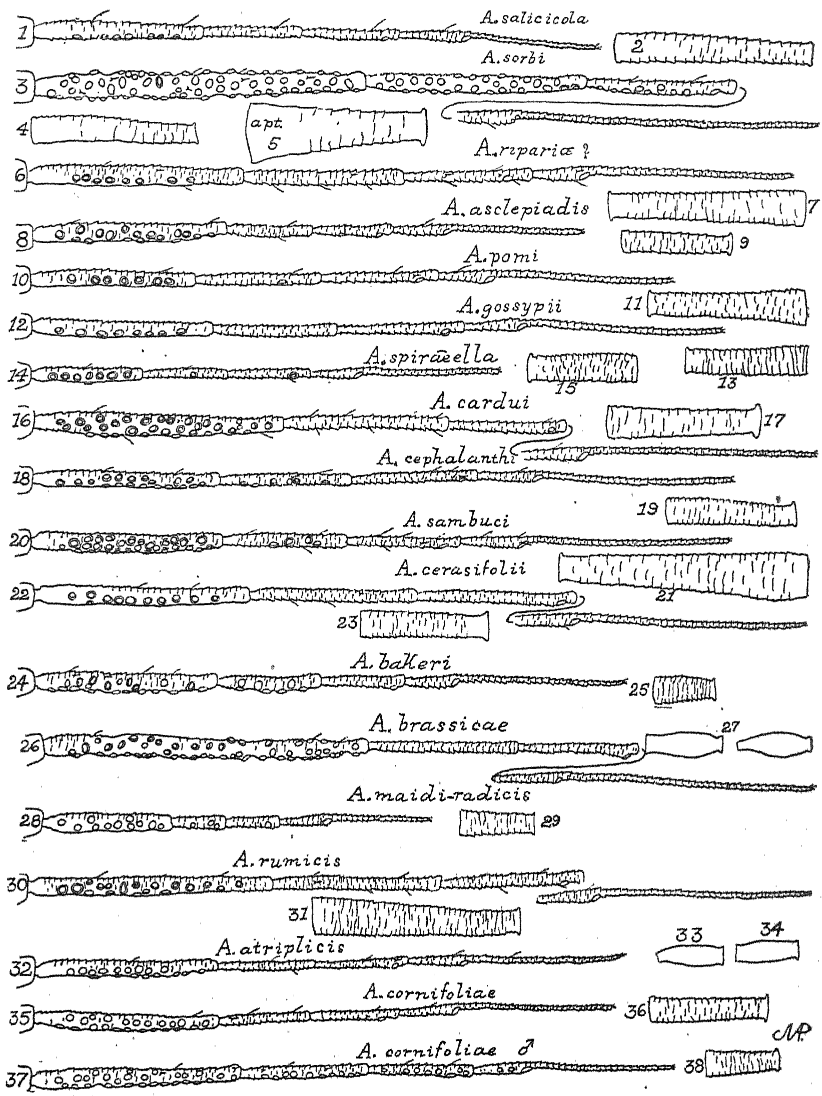
Aphis rumicis L., Figs. 30 and 31. Taken at Chicago on *Rumex crispus* (yellow dock), Lansing and Detroit on garden beets, Geneva and Washington, D. C., on burdock (*Lappa officinalis*), Corvallis and Oregon City on burdock, yellow dock and Lamb's quarter (*Chenopodium*), and at Seattle on Lamb's quarter.

The white spots and dashes upon the abdomen of the pupæ, and often of the apterous viviparæ of this black louse are quite characteristic and yet there is much danger of its being confused with closely allied species. Figures 30 and 31 are from alate lice taken from *Rumex crispus* at Chicago, June 23, 1909, and which agree well in structure with examples of this species sent me by Prof. T. D. A. Cockerell from Sussex, England, taken upon *Dipsacus* sp. and others labelled "*A. rumicis*" from H. F. Wilson, taken at Washington, D. C., Nov. 21, 1908, on *Rumex* sp.

Aphis atriplicis L. Taken at Portland, Mich., Geneva, New York City, Washington, and Corvallis and Hood River, Ore. This is a very abundant species generally distributed in Colorado upon both sides of the mountains and up to fully 7,000 feet altitude. This species was described by Mr. Cowen, in Bull. 31 of the Colorado Experiment Station as *A. chenopodii.* Figs. 32, 33 and 34 are from examples taken at Fort Collins, on *Chenopodium,* June 12, 1909.

Aphis cornifoliæ Fh., Figs. 35, 36, 37, and 38. Taken at Portland,

Plate 26



Antennæ of Aphididæ

Ore., August 20, 1909, on *Cornus* sp. The fall migrants were just beginning to form colonies on the leaves. This is an abundant species in Colorado, the eggs being deposited on twigs of *Cornus stolonifera* in the fall by apterous females that are the young of the migrants. In the spring the migrants leave the dog-wood and go to *Helianthus* for the summer. We have many times observed this habit in Colorado, and Mr. L. C. Bragg has artificially colonized this species both ways between these plants.

The figures are from fall migrants, taken at Fort Collins, Col., on *Cornus stolonifera*, Sept. 29, 1909. We have also taken this louse on *Iva xanthifolia* and in large numbers upon *Ribes aurem*. The male antenna is peculiar in having several sensoria upon all the joints beyond the second.

A. gillettei Cowen is a synonym of this species, but *helianthi* Monell seems probably to be a distinct species judging from an examination of balsam material sent me by Mr. Monell, and taken at St. Louis, Mo., July 7, 1910. Monell's specimens are somewhat smaller and have relatively shorter antennæ and cornicles, and the alate viviparæ lack the blackish patches at the base of each cornicle. The two forms, if distinct, are very closely allied. I find no difference in number or distribution of the sensoria.

Plate 26. *Aphididæ.* Unless otherwise marked, all figures are multiplied 70 times, and are from alate viviparous females. 1 and 2, *Aphis salicicola*; 3, 4, and 5, *A. sorbi;* 6 and 7, *A. ripariæ* (?); 8 and 9, *Aphis asclepiadis*; 10 and 11, *A. pomi*; 12 and 13, *A. gossypii*; 14 and 15, *A. spiræella*; 16 and 17, *A. cardui*; 18 and 19, *A. cephalanthi*; 20 and 21, *A. sambuci*; 22 and 23, *A. cerasifolii*; 24 and 25, *A. bakeri*; 26 and 27, (two views), *A. brassicæ*; 28 and 29, *A. maidi-radicis*; 30 and 31, *A. rumicis*; 32, 33 and 34 (two views), *A. atriplicis*; 35, 36, 37 (male), 38 (male), of *A. cornifoliæ*.—Miriam A. Palmer, Delineator.

A LIST OF THE APHIDIDÆ OF ILLINOIS, WITH NOTES ON SOME OF THE SPECIES

By JOHN J. DAVIS, *Office of the State Entomologist, Urbana, Illinois*

In this catalogue of the Aphididæ of North America (1901), Professor W. D. Hunter lists 98 species as having been recorded from Illinois. Since then, from records in literature and personal collections, the list has been increased to 170 species. Many more have been collected by us which we are at present unable to identify, either because of too little material or the apparent confusion of certain groups, which will require larger numbers of collections to work out satisfactorily. Following each species are one or more references to the most comprehensive descriptions of the various forms in Amer-

ican literature, together with brief notes on the economic importance, if any, and the first record of its occurrence in Illinois. An asterisk (*) before the species indicates that it is here recorded from Illinois for the first time, those having Illinois as the type locality are referred to by a " *t* " before the name, and those doubtfully occurring in Illinois, having only been reported by Hunter's compiled list.[1], so far as I have been able to find, are noted by a " *d* " before the name.

[t] *Tychea brevicornis* Hart: 18th Rept. St. Ent. Ill. (1894), p. 97, 1 fig. Not uncommon in Central Illinois on the roots of grass, *Euphorbia*, and corn, but of very little economic importance. First reported by Forbes.

[t] *Trama erigeronensis* Thos.: Hart, *loc. cit.*, p. 93, 1 fig. Common at Urbana, Ill., on dandelion roots, invariably attended by the ant, *Lasius flavus*. Also common on roots of *Erigeron canadense* and corn. First reported by Thomas.

[t] *Forda occidentalis* Hart: *loc. cit.* p. 95, 1 fig. Common on grass and corn roots and occasionally injurious. First reported by Forbes.

[t] *Rhizobius eleusinis* Thos.: List of Aphid. U. S., Bull. 2, Ill. St. Lab. Nat. Hist. (1878), p. 15. I have never taken this species, which Thomas described from specimens collected on roots of *Eleusine indica* at Carbondale, Ill.

[d] *R. lactucæ* Fitch: 14th Rept. Ins. N. Y. (1872), p. 360. Thomas quotes Fitch, and there is no mention of its occurrence in Illinois.

[t] *R. poæ* Thos.: 8th Rept. St. Ent. Ill. (1879), p. 166. Mr. C. A. Hart considers this as probably a *Dactylopius*. First reported by Thomas, which is the only record of its collection, so far as I am able to learn.

[t] *R. spicatus* Hart: 18th Rept. St. Ent. Ill. (1894), p. 104, 1 fig. A rare species occurring on roots of grass, *Panicum*, and corn. First reported by Forbes.

Phylloxera caryæcaulis Fitch: Pergande, N. A. Phylloxerinæ, Vol. 9, Davenport Acad. Sci. (1904), p. 244, 2 figs. This is the commonest species of *Phylloxera* attacking hickory in Illinois, but like the other species of this genus it rarely becomes sufficiently abundant to require artificial means of control. First reported by Shimer.

P. caryæ-fallax Riley: Pergande, *loc. cit.* p. 214, 6 figs. First reported by Pergande.

P. caryæfoliæ Fitch: Pergande, *loc. cit.* p. 194, 2 figs. I have taken this hickory gall-maker on several occasions in Northern Illinois. My collection of winged females have been made throughout the month of June. First reported by Pergande.

[1] The Aphididæ of North America, by W. D. Hunter. Bull. Ia. Agr. Exper. Sta., No. 60, Sept. 1901.

[t] *P. caryæ-globuli* Walsh: Pergande, *loc. cit.* p. 222. (Quotes the scattered description of Walsh and Shimer.) I found this species on hickory at Lake Forest, Ill., June 29, 1909, the galls at that time containing large numbers of the winged individuals. After an initial determination by the writer, specimens were sent to Mr. Theo. Pergande who, in a letter of April 4, 1910, said, "The real *Phyll. caryæ-globuli* Walsh I had never seen before, though I think you may be right." First reported by Walsh.

[d] *P. caryæ-gummosa* Riley: 7th Rept. St. Ent. Mo. (1875), p. 118; Pergande, *loc. cit.* p. 238, 3 figs. I find no record of its occurrence in Illinois.

[t 1] *P. caryæ-semen* Walsh: Pergande, *loc. cit.* p. 211, 2 figs. I do not know this species. First reported by Shimer.

[t] *P. caryæ-septem* Shimer: Pergande, *loc. cit.* p. 190, 7 figs. I am unacquainted with this hickory gall-maker. First reported by Shimer.

[d] *P. caryævenæ* Fitch: Pergande, *loc. cit.* p. 239, 10 figs. I find no record of its occurrence in Illinois, other than that in Hunter's Catalogue.

[t] *P. conica* Shimer: Pergande *loc. cit.* p. 225, 7 figs. First reported by Shimer.

[t] *P. depressa* Shimer: Trans. Amer. Ent. Soc., Vol. 2, p. 389 (Pergande *loc. cit.* p. 208, quotes Shimer). First reported by Shimer.

[t] *P. foveata* Shimer (=*foveatum* Shimer). Trans. Amer. Ent. Soc., Vol. 2, p. 393 (Pergande, *loc. cit.* p. 209, quotes Shimer). First reported by Shimer.

[t] *P. globosum* Shimer: Pergande, *loc. cit.* p. 236, 4 figs. Quotes and discusses Shimer's confused descriptions. First reported by Shimer.

[t] *P. minimum* Shimer: Trans. Amer. Ent. Soc., Vol. 2, p. 391 (Pergande, *loc. cit.* p. 210, quotes Shimer). First reported by Shimer.

[d] *P. rileyi* (Licht. MS.) Riley: Pergande, *loc. cit.* p. 261, 4 figs. I find no record of this species having been taken in Illinois other than that in Hunter's Catalogue.

* *P. salicola* Perg.: *loc. cit.* p. 267, 8 figs. This species is very common in some of the Chicago parks. It occurs in the crevices of the trunk and larger branches of the willow, appearing as small white flocculent masses, and when abundant, as it sometimes is, gives the willow trunks an unsightly appearance.

[t] *P. subelliptica* Shimer: Pergande, *loc. cit.* p. 239, 10 figs. Quotes Shimer in full. First reported by Shimer.

P. vitifoliæ Fitch (=*vastatrix* Planch.): Riley, 6th Rept. St. Ent.

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[1] Although Walsh does not give any definite locality, he very probably collected it in Illinois.

Mo. (1872), p. 30, figs. Common but of little economic importance in Illinois. First reported by Walsh.

[d] *Chermes pinifoliæ* Fitch: Patch, Bull. Maine Agr. Expt. Sta. No. 173 (1910), p. 277, 9 figs. Thomas named this species *abieticolens*, quoting the brief and unsatisfactory description of the gall as given by Packard and reproduced Packard's figure. Packard found the species in Maine and there is no reason to believe that Thomas found it in Illinois, as Hunter has supposed in his catalogue.

C. pinicorticis Fitch: Storment, 20th Rept. St. Ent. Ill. (1897), Appendix, pp. III–XXVI, figs. First reported by Walsh.

[t] *Geoica squamosa* Hart: 18th Rept. St. Ent. Ill. (1894), p. 98, 5 figs. Common on grass roots and occasionally on corn roots, but never, to my knowledge, in sufficient numbers to be injurious. First reported by Forbes.

[t] *Hamamelistes spinosus* Shimer: Pergande, Tech. Bull. Div. Ent., U. S. Dept. Agr., No. 9, p. 25, 12 figs. I have found this species very common on cultivated witch-hazel at Chicago, and wild witch-hazel growing in a timber at Kankakee. Of little economic importance. First reported by Shimer.

[t] *Pemphigus aceris* Monl.: Can. Ent., Vol. XIV (1882), p. 16. First reported by Monell.

* *P. betæ* Doane: Bull. 42, Wash. Agr. Expt. Sta. (1900), p. 3, 1 fig. Last September (1909) I collected wingless individuals of what I then determined as *Tychea brevicornis* Hart on the roots of *Bidens vulgata* at Oak Park, Ill. At that time only wingless forms were found. Later in the fall (Oct. 9), winged specimens were found on the roots of the same group of plants, a species I have determined as *P. betæ* after comparison with specimens received from Professor Gillette. The observations, although scanty, would seem to indicate the possible synonymy of the two species.

* *P. corrugatans* Sirr. (?): Ia. Acad. Sci., f. 1893, Vol. I, pt. IV (1894), p. 129. What I have been calling *Pemphigus pyri?* was found at Le Roy, Ill., July 7, 1907, corrugating the leaves of *Cratægus* sp. The pseudo galls and winged viviparous females agree fairly well with the description given by Sirrine for *P. corrugatans*, excepting the relative lengths of the antennal segments IV and V. In my Le Roy specimens segment IV is invariably slightly longer than V, while in the description of *corrugatans*, Sirrine gives Segment IV, .13 mm. and V, .17 mm. long.

[t] *P. formicarius* Walsh: Proc. Ent. Soc. Phila., Vol. I (1862), p. 308. This is an unknown species, it not having been reported since Walsh's original description. First reported by Walsh from Rock Island, Ill.

[t] *P. formicetorum* Walsh: *loc. cit.* p. 308. Nothing known of this

species excepting Walsh's original observations. First reported by Walsh from Rock Island, Ill.

* *P. fraxinifolii* Riley: Bull. U. S. Geol. Surv., Vol. 5 (1897), p. 17. Very common on green ash throughout the state, and one of the important pests of that tree. Further than the direct injury, the pseudogalls (curled leaves) of the insect gives the tree a very unsightly appearance. Specimens of this species were sent to Dr. G. Del Guercio who reported it distinct from the European ash *Pemphigus*, *P. nidificus* Löw. He has published an account of the differences in the two species in "Rivista di Patologia Vegetale," Anno IV, No. 4. The only additional contribution to the life history that we have to make is that the oviparous females are produced in the fall and are to be found in the crevices of the bark on the ash-tree trunk. These females produce but one egg each as do other Pemphigians.

P. populicaulis Fitch: Jackson, Columbus Hort. Soc., Vol. 22 (1908?), p. 191. This poplar gall-maker is common at Urbana, but I have failed to find it in Northern Illinois. First reported by Walsh.

* *P. populi-transversus* Riley: Bull. U. S. Geol. Surv., Vol. 5 (1879), p. 14, 1 fig. Common throughout the state on the cottonwood.

[t] *P. pseudobyrsa* Walsh: Proc. Ent. Soc. Phila., Vol. I (1862), p. 306. This is one of the unknown species. The original collection of the species by Walsh at Rock Island, Ill., appears to be the only record of its capture.

P. rhois Fitch: Jackson, Columbus Hort. Soc., Vol. 22 (1908), p. 202. First reported by Walsh.

[t] *P. rubi* Thos.: 8th Rept. St. Ent. Ill. (1880), p. 147. There is no reference to the collection of this species since the original description. First reported by Thomas.

* *P. tessellatus* Fitch: Jackson, Columbus Hort. Soc., Vol. 22 (1908?), p. 183; Patch, Ent. News, Vol. XIX (1908), p. 484, 1 pl. This species is injuriously abundant on the alders in the Chicago parks. I follow Miss Patch in considering *P. acerifolii* Riley a synonym. It has never been recorded from Illinois, except in Hunter's Catalogue and by Jackson, who seems to have followed Hunter.

[t] *P. ulmi-fusus* Walsh and Riley: Amer. Ent. Vol. I (1869), p. 109. A rare species which I have taken on elm at Leroy and Urbana, in the central part of the state. First reported by Walsh and Riley.

[t] *Mordwilkoja vagabunda* Walsh (*œstlundi* (Ckll.): Oestlund, Bull. Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 22. A common poplar gall-maker in Northern Illinois, especially abundant in the vicinity of Chicago. Often the street trees are so covered with these galls as to make them quite unsightly in winter. I have never taken this species south of Kankakee, Ill. First reported by Walsh.

* *Colopha ulmicola* Fitch: (*eragrostidis* Middl.)Riley, Bull. U. S. Geol. and Geog. Surv., Vol. 5, No. 1, (1879), p. 9; Patch, Bull. Me. Agr. Expt. Sta. No. 181 (1910), p. 196, 11 figs. A very common species. The galls are often so abundant on elms as to give the trees an unsightly appearance. As Miss Patch has recently pointed out, *C. eragrostidis* Middl. is doubtless a synonym of *C. ulmicola* Fitch.

* *Schizoneura americana* Riley: Bull. U. S. Geol. and Geog. Surv. Vol. V, No. 1 (1879), p. 4, figs. A common pseudo-gall-maker on elm and not infrequently injuriously abundant.

[t] *S. caryæ* Fitch: 3rd Rept. Ins. N. Y. (1856), p. 443. This species is unknown to the writer. First reported by Fitch.

S. corni Fabr.: Oestlund, Bull. Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 28. This is a common species on *Cornus sanguinea et* spp. throughout the state. First reported by Walsh under the name *cornicola* Walsh.

S. cratægi Oestl.: Bull. Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 27. A serious pest of the hawthorns used in ornamental plantings in Chicago, being especially common on *Cratægus crus-galli.* First reported by the writer.

ON *CRATÆGUS*, SEPT., 1909. DUNNING, ILL.

Antennal segment	Measurements in mm.							
III	0.4075	0.4075	0.3993	0.4075	0.4075	0.4156	0.4156	0.4075
IV	0.1222	0.1141	0.1141	0.1222	0.1222	0.1141	0.1222	0.1141
V	0.1385	0.1304	0.1304	0.1385	0.1385	0.1385	0.1385	0.1304
VI	0.1141	0.1141	0.1141	0.1141	0.1141	0.1141	0.1141	0.1141

S. lanigera Haus.: Gillette, Jour. Econ. Ent., Vol. I (1908), p. 306, colored and other figs. A common and destructive apple pest throughout the state. First reported by Thomas. Antennal measurements given below for comparison with *S. cratægi.*

ON APPLE IN GREENHOUSE, URBANA, ILL., 18 NOV., 1907.

Antennal segment	Measurements in mm.							
III	0.4156	0.4238	0.3993	......	......	......	......	......
IV	0.1141	0.1141	0.1141	......	......	......	......	......
V	0.0978	0.1059	0.0978	......	......	......	......	......
VI	0.0978	0.0896	0.0815	......	......	......	......	......

S. panicola Thos.: Hart 18th Rept. St. Ent. Ill. (1894), p. 90, 2 figs. Common on roots of *Panicum* and occasionally on corn roots, but of little or no economic importance. It has still to be proven that this is identical with *S. corni*. First reported by Forbes.

[t]*S. querci* Fitch: 5th Rept. Insects N. Y. (1859), p. 804. This species has not been recorded from Illinois since the first record by Fitch. I have taken a species on oak leaves several times in Northern Illinois, which is, I believe, the species referred to by Oestlund and Cowen as Fitch's *querci*. However my oak aphid, which is found in colonies beneath a rather dense cottony secretion, is a *Phyllaphis*, apparently undescribed, and will be described fully in another paper. First reported by Fitch.

[t][1] *S. rileyi* Thos. (*ulmi* Riley): Riley, 1st Rept. St. Ent. Mo. (1869), p. 123. A serious pest of the elm throughout the state. First reported by Riley.

[t] *Mindarus abietinus* Koch (=*pinicola* Thos.): 8th Rept. St. Ent. Ill. (1880), p. 137; Patch, Bull. 182, Me. Agr. Expt. Sta. (1910), p. 242, 7 figs. This species has never been taken in Illinois since the original description. First reported by Thomas.

[d] *Phyllaphis fagi* Linn.: Thomas, 8th Rept. St. Ent. Ill. (1880), pp. 120, 140; Weed, Trans. Amer. Ent. Soc., Vol. 20, p. 303, 3 figs. (?) Other than in Hunter's Catalogue, this species has not been reported from Illinois.

Longistigma caryæ Harr. (? ?): Sanborn, Kans. Uni. Sci. Bull., Vol. 3 (1904), p. 30, figs. (*L. longistigma*). What has been heretofore known as *L. longistigma* on linden and *L. platanicola* on sycamore, are common throughout the state, the winged males and wingless oviparous females making their appearance during October in Northern Illinois, the large eggs being deposited in the crevices of the bark as well as on the smaller branches. First reported by Fitch (?).

[d] *Lachnus abietis* Fitch: Cat. Homopt. N. Y. (1851), p. 67. There is no record of the occurrence of this *Lachnus* in Illinois other than in Hunter's Catalogue.

[t][2] *L. dentatus* Le B.: 3rd Rept. (2nd of Le Baron), St. Ent. Ill. (1872), p. 138, figs.; Weed, Bull. Ohio Agr. Expt. Sta., Tech. Ser., Vol. 1, No. 2 (1890), p. 117, figs. A common species in Northern Illinois, becoming very abundant in the fall, and on ornamental willows it is a considerable nuisance. First reported by Le Baron (?).

[d] *L. quercifoliæ* Fitch: Cat. Homopt. N. Y., p. 67, 1851. This

[1] Chicago, Ill. and St. Louis, Mo., type localities.

[2] Although not definitely stated, Le Baron probably described this species from Illinois specimens.

species appears to be lost and it is doubtful if the species collected by Thomas in Illinois is the same as that described by Fitch in New York.

[d]*L. strobi* Fitch: 1st Rept. Ins. N. Y. (1855), p. 256; Weed, Bull. Agr. Expt. Sta. Ohio, Tech. Ser., Vol. 1, No. 2 (1890), p. 116, figs. This species has never been reported from Illinois except in Hunter's Catalogue.

[t]*Sipha flava* Forbes: Davis, Tech. Ser. Bur. Ent., U. S. Dept. Agr., No. 12, Pt. VIII (1909), p. 156. Common in Central Illinois on various grasses, corn, wheat, sorghum, and broom corn. On the latter two it often becomes destructive. First reported by Forbes.

***Brachycolus tritici* Gillette Mss. I found this species common on grass at Aurora, Illinois, Sept. 24, 1908. Specimens were sent to Prof. C. P. Gillette, who replied that he had recently taken the species and had described it in manuscript under the above name.

[t]*Melanoxantherium smithiæ* Monl.: Bull. U. S. Geol. and Geog. Surv. No. 5 (1879), p. 32; Weed, Psyche, Vol. V (1889), p. 132. A species which often becomes excessively abundant on the branches of willow in the fall. In parks and other much frequented places these insects are a serious nuisance because of the blood-red stain caused when the soft-bodied aphids are crushed, this stain discoloring and ruining the clothing. First reported by Monell.

Chaitophorus aceris Linn.: Common on hard and Norway maples in Northern Illinois and apparently becoming more common every year. Although not a serious pest at present, it is likely to become one within a few years. It is found on the maples throughout the year, the sexual forms (winged male and wingless oviparous female) occurring in September and October. The dimorphs were not observed, which, however, may be accounted for by the fact that I was not able to make continuous observations the past year (1909). After comparing with sketches of the abdominal markings, as well as a specimen of each of the winged and wingless viviparous females of *Ch. aceris*, received from Doctor Del Guercio of Italy, I am inclined to consider our species distinct from the European *aceris*, but further study is necessary.[1] First reported by Gillette.

[d]*Ch. candicans* Thos.: Mentioned by Thomas but never described, hence *nomina nuda.*

[t]*Ch. negundinis* Thos.: Oestlund, Bull. Geol. and Nat. Hist. Surv.

[1] In going over the species of *Chaitophorus*, with a view of monographing the genus, the writer has found many difficulties, necessitating studies continued throughout the year to determine the constancy of the color patterns and measurements. This is especially true of the poplar *Chaitophorus* of which we likely have several undescribed species.

Minn., No. 4 (1887), p. 37; Weed, Insect Life, Vol. 3 (1891), p. 287, figs.; Davis, Ent. News, Vol. 21 (1910), p. 14, figs. Common throughout the state and a pest of considerable importance on box elder. First reported by Thomas.

[t]*Ch. populicola* Thos.: Sanborn, Kans. Uni. Sci. Bull., Vol. 3 (1904), p. 36, figs. One of our most common species of *Chaitophorus* in Illinois, occurring throughout the state. The several forms (winged male with wings marked as are those of the viviparous female, and oviparous female) are to be found on poplar twigs and leaves in September. First reported by Thomas.

[t]*Ch. quercicola* Monl.: Bull. U. S. Geol. and Geog. Surv., No. 5 (1879), p. 32; Oestlund, 14th Ann. Rept. Geol. and Nat. Hist. Surv. Minn. (1886), p. 49, (*spinosus*). I took the oviparous forms of this species on the under surfaces of the leaves of post oak (*Quercus obtusiloba*) at Kankakee, Ill., Oct. 13, 1908, and have received winged and wingless viviparous forms from Mr. W. P. Flint, who collected them on white oak (*Q. alba*), at Heyworth, Ill., April 10, 1908. The specimens agree in every particular with the descriptions of *Callipterus quercifolii* Thos. and *Chait. spinosus* Oestl., both of which species I consider synonyms of Monell's *quercicola*. First reported by Monell.

Winged viviparous female.—The following notes are offered to supplement Monell's description.[1] Antennæ with 5–8 sensoria in a row on III; from the alcoholic specimens the coloration appears as follows: I, II, and III, dusky excepting a small pale area a little beyond the center of III. IV and V, pale except the dusky tips, and VI entirely dusky except basal half of base VI. Abdomen with a row of dusky tubercular areas bearing spines on the dorsum, these being most conspicuous at the anterior end; a similar row on each side. Plate 27, figures 1 and 2.

Wingless viviparous female.—The descriptions given by Monell [2] and Oestlund [3] are quite characteristic for the species.

The excellent description of the wingless oviparous female given by Oestlund [4] agrees exceedingly well with my notes and specimens.

**Ch. viminalis* Monl.: Bull. U. S. Geol. and Geog. Surv., No. 5 (1879), p. 31; Weed, Psyche, Vol. 5 (1889), p. 133. Common in all parts of the state on willow. It varies greatly in color,—from a light

[1] Notes on the Aphididæ of the United States, etc. Bull. U. S. Geol. and Geog. Surv., Vol. V, No. 1, p. 32, 1879.

[2] *Loc. cit.*

[3] Synopsis of the Aphididæ of Minn. Bull. 4, Geol. and Nat. Hist. Surv. Minn., p. 38, 1887.

[4] List of the Aphididæ of Minn., etc. 14th Ann. Rept. Geol. and Nat. Hist. Surv. Minn., p. 50, 1886.

brown to almost black, indeed not only the color but the lengths of the antennal segments and numbers of antennal sensoria vary so much that I have been unable to distinguish between this species and Oestlund's *Ch. nigræ*.

* *Callipterus* (*Pterocallis*[1]) *alni* Fabr.: This species is rather common on the lower surface of the leaves of alders in the Chicago parks, and when abundant, as it often is, the upper surfaces of the lower leaves become heavily coated with the honey dew. I believe this species has not before been recorded as occurring in the United States. According to the table of American species of *Callipterus* given by Mr. J. T. Monell,[2] *alni* comes nearest to *C. hyalinus* Monl., from which it may be distinguished by the blackish wing veins, the black tipped cornicles, filament of antennal segment VI shorter than base, etc. Inasmuch as there is no description of this species in American literature, I describe in full the viviparous and sexual forms.

Winged viviparous female.—Head pale greenish yellow, Pl. 27, fig. 3, first thoracic segment pale greenish, thoracic shield pale with a faint brownish tint, and abdomen pale yellowish or greenish yellow with a more or less distinct dorsal transverse green marking near the anterior end, another near the cornicles and a median longitudinal marking, usually indistinct, connecting the two. Antennæ about as long as the body, segment III longest, IV about two-thirds the length of III, V a little shorter than IV, base VI less than one-half the length of V, and filament VI slightly shorter than base VI; 2 to 4 large but rather inconspicuous circular sensoria near the base of III, and the usual ones at the distal ends of segments V and base VI; I and II concolorous with head, III and IV pale (whitish) excepting the distal ends, which are black, V pale at base and gradually darkening to blackish at distal end, VI blackish. (Pl. 27, fig. 4). Eyes red. Beak rather short, reaching a little beyond the coxæ of the first pair of legs. Wings hyaline with rather conspicuous dark brown veins which are apparently bordered with an almost imperceptible pale browning tint, stigma with a dark brown area at each end, stigmal vein hyaline or sub-hyaline except the distal third. (Pl. 27, fig. 5.) Legs pale excepting dusky distal ends of the tibiæ and the blackish tarsi. Cornicles tubercular and black excepting the pale base. (Pl. 27, fig. 6.) Style pale knobbed, anal plate very conspicuously bifid. (Pl. 27, fig. 7.) Measurements,—length of body, 1.4 mm., width, 0.53 mm.; length of wing, 2.2 mm., width, 0.79 mm.; antenna, I, 0.05; II, 0.05; III, 0.4890–0.5460, avg., 0.51; IV, 0.3079–0.3423, avg., 0.33; V, 0.2445–0.2934, avg., 0.27; VI, base 0.1141–0.1304, avg., 0.12; VI, filament, 0.0896–0.1141, avg., 0.0978; avg., total, 1.4278 mm.; cornicles, 0.05–0.06 mm.; styles, 0.115 mm.

Wingless oviparous females.—Head pale greenish yellow, thorax and abdomen pale greenish with darker green dorsal markings as follows: irregular transverse patch near head, another narrower one anterior to the center and a third near the

[1] For the present I prefer to use the genus *Callipterus* rather than *Pterocallis*. There is every gradation between the two so-called genera. If we take as a criteria the characters for dividing the old genus *Callipterus*, used by several European authors, there would be sufficient reason for the erection of several new genera among the American species of *Callipterus*.

[2] Notes on Aphididæ, Can. Ent., Vol. 14, Jan. 1882, p. 13–16.

cornicles. Eyes red. Antennæ as those of winged viviparous female as to relative lengths of segments and coloration. (Pl. 27, fig. 8.) Beak as in winged, legs also as in winged, excepting the hind femora which are swollen the basal two-thirds and bear many small inconspicuous circular sensoria. (Pl. 27, fig. 9.) Coloration of style and cornicles as given for the viviparous. Abdomen more tapering and drawn out at the posterior end. On the ventral lateral surface just beneath the cornicles is a silvery white patch which proves to be a mass of fine flocculent matter, from glands beneath, and probably is used as a protection for the eggs mentioned below. Measurements (average), length of body, 1.7 mm.; width, 0.8 mm.; antennæ, I, 0.05; II, 0.05; III, 0.38; IV, 0.21; V, 0.19; VI, base, 0.115; filament, 0.098; total, 1.093 mm. Eggs.—They are deposited in the crevices at the buds and are more or less covered with the silvery white flocculent matter found at the glands beneath the cornicles mentioned above. When first deposited they are pale greenish, later changing to jet black.

Winged male.—Head and thorax dark brownish, sometimes prothorax with a greenish tint. Abdomen pale yellowish green, with the green markings similar, but less conspicuous than in the winged viviparous female. Antennæ entirely dusky, 12–14 rather large circular sensoria in a row on III, 5–7 on IV, and 3–5,—together with the usual distal one,—on V, and the usual one at end of VI base. (Pl. 27, fig. 10.) Legs entirely dusky excepting joints and base of femur. Cornicles and eyes and wings as in winged female. Styles dusky. Measurements (average): length of body, 1.2 mm.; width, 0.49 mm.; antenna I, 0.055; II, 0.065; III, 0.46; IV, 0.29; V, 0.25; VI, base, 0.12; VI, filament, 0.105; total, 1.345 mm.

Cal. asclepiadis Monl.: Bull. U. S. Geol. and Geog. Surv., Vol. 5 (1879), p. 29; Oestlund, Bull. Geol. and Nat. Hist. Surv., Minn., No. 4 (1887), p. 42. Found abundant on the common *Asclepias*, throughout the state. First reported by Gillette.

* *Cal. bellus* Walsh: Sanborn, Kans. Uni. Sci. Bull., Vol. 3 (1904), p. 40, figs. Common throughout the state on oak.

Cal. betulæcolens (Fitch) Monl.: Bull. U. S. Geol. and Geog. Surv., Vol. 5 (1879), p. 30; Davis, Annals Ent. Soc. Amer., Vol. 2 (1909), p. 30, figs. Especially abundant on the American and European lindens in the Chicago parks. At Elgin, Ill., this species was exceptionally abundant, the upper surfaces of the linden leaves being coated with honey dew, and the aphids, when disturbed, arose from the leaves in small swarms giving the general impression of a flight of small leaf hoppers, such as *Empoasca mali*. First reported by the writer.

* *Cal. caryæ* Monl.: Bull. U. S. Geol. and Geog. Surv., Vol. 5 (1879), p. 31. A species occurring everywhere throughout the state on hickory and walnut.

[t] *Cal. caryæfoliæ* Davis: Ento. News, Vol. 21, May (1910), pp. 198–200, 1 pl., 1 fig. First reported by the writer.

* *Callipterus* (*Myzocallis* [1]) *coryli* Goetze: This species has been taken occasionally on the wild and cultivated hazel shrubs, infesting

[1] See note under *Pterocallis* on a preceding page.

the under surfaces of the leaves, in and about Chicago. In Monell's table[1] this species comes nearest to *C. betulæcolens* from which it may be readily distinguished by its smaller size, the pale wing veins, shorter filament in comparison with the base of VI, etc. *C. coryli* was once before reported from the United States, by W. T. Clarke, who collected it in California[2].

Winged viviparous female.—Entire body, including head, (Pl. 28, fig. 11) pale yellow. Antennæ whitish excepting the tips of III, IV, V, distal half of base VI, and filament VI; segment III longest, it being fully a half longer than IV, IV, V, and filament VI subequal, but IV being invariably slightly the longest of the three, VI base being less than half the length of VI filament; three or four large but inconspicuous circular sensoria near the base of III, and the usual ones at the distal ends of V and VI base. (Pl. 28, fig. 12.) Eyes white from above and reddish from below. Beak reaching to the coxæ of the second pair of legs. Legs pale (whitish) excepting the pale dusky distal end of tibia and blackish tarsus. Cornicles concolorous with body; longer than wide but the length less than twice the breadth. (Pl. 28, fig. 14.) Style concolorous with body and knobbed. Anal plate conspicuously bifid. (Pl. 28, fig. 15.) Measurements (average): length of body, 1.1 mm.; width, .046 mm.; length of wing, 1.8 mm.; width, 0.7 mm.; antenna I, 0.055; II, 0.065; III, 0.42; IV, 0.26; V, 0.20; VI, base, 0.105; VI, filament, 0.23; total, 1.335 mm.; cornicles, 0.065 mm.; style, 0.05 mm. Pupa, entirely pale yellow.

Wingless oviparous female.—Entire body pale yellowish. Eyes reddish. Antennæ pale whitish, excepting extreme distal end of III and the remaining segments, which are more or less dusky. Comparative measurements as winged viviparous. (Pl. 28, fig. 16). Legs pale whitish excepting distal end of tibia and the tarsus, which are dusky, hind tibia swollen and bearing rather inconspicuous sensoria on the basal two-thirds. (Pl. 28, fig. 17). Entire body covered with rather long capitate hairs; on the dorsum is a longitudinal row of tubercules, bearing hairs. Abdomen prolonged at the posterior end. Cornicles and style concolorous with the body. Measurements (average): length of body, 1.5 mm.; width, 0.7 mm.; antenna I, 0.05; II, 0.04; III, 0.26; IV, 0.16; V., 0.145; VI, base, 0.09; VI, filament, 0.20; total, 0.945 mm.; cornicles, 0.08 mm.

Winged male.—Head dusky with a faint dark greenish tint; prothorax yellowish with a median longitudinal marking concolorous with head. Thoracic shield shining dark greenish, and abdomen pale yellowish with a median row of short wide transverse black markings and a row of inconspicuous dusky spots on each side. Antennæ as follows: I and II dusky, III pale, and dusky at distal end, the remaining segments dusky to blackish; 17–18 roundish oval irregularly placed sensoria on III, 3–5 in a row on IV, 3-5 on V, and 1-3 on base VI, as well as the usual ones at the distal ends of V and base VI; III longest, it being more than a half longer than IV and about twice the length of VI filament, IV and V subequal, the former being invariably slightly the longer, VI base about one half the length of the filament which is subequal to or slightly less than the length of V. (Pl. 28, fig. 18.) Wing veins slightly darker than the female. Legs pale or slightly dusky, excepting the darker distal end of the tibia and the tarsus. Cornicles and style dusky. Measurements (average): length of body, 1.0 mm.; width, 0.35 mm.; length of wing, 2.25 mm.; width, 0.71 mm.; antenna I, 0.05; II, 0.05; III, 0.42; IV, 0.24; V, 0.215; VI, base, 0.10; VI, filament, 0.215; total, 1.29 mm.

[1] *Loc. cit.*

[2] A list of California Aphididæ, Can. Ent., Vol. 35 (1903), p. 248.

* *Cal. discolor* Monl.: Oestlund, Bull. Geol. and Nat. Hist. Surv., Minn., No. 4 (1887), p. 41; Weed, Psyche, Vol. 4, (1889) p. 131. A common species on the oaks (*Quercus* spp.).

Cal. hyperici Monl.: Bull. U. S. Geol. and Geog. Surv., Vol. 5 (1879), p. 25 (*Aphis*). First reported by Thomas.

* *Cal. punctatus* Monl.: Bull. U. S. Geol. and Geog. Surv., Vol. 5 (1879), p. 30. Not uncommon in Illinois on oak.

Cal. trifolii Monl.: Davis, Annals Ent. Soc. Amer., Vol. 1 (1908), p. 256, figs. A common species on clover, but of little economic significance. First reported by the writer.

Cal. ulmifolii Monl.: Bull. U. S. Geol. and Geog. Surv., Vol. 5 (1879), p. 29; Oestlund, Bull. Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 42. Abundant on *Ulmus americana* throughout the year, the sexual forms (winged male and wingless female), being common in September and October. Although not usually considered injurious to the elm, I have occasionally found them sufficiently common to do injury, causing the foliage to drop prematurely and coating the upper surfaces of the leaves with honey dew. First reported by Gillette.

[t] *Calaphis betulella* Walsh: Proc. Ent. Soc. Phila., Vol. 1 (1862), p. 301. I have never taken this interesting species, but Walsh reported it from Illinois in his original description. Mr. J. T. Monell has kindly sent me specimens collected by him at St. Louis, Mo., on the leaves of birch. Camera lucida drawings of the head, wing, cornicles, and style are given in Plate 28, figures 19 to 23.

* *Monellia caryella* Fitch: Oestlund, Bull. Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 45. I have collected this species but once, namely on hickory at Centralia, Ill., August 13, 1907.

Drepanaphis acerifolii Thos.: Sanborn, Kans. Uni. Sci. Bull., Vol. 3, No. 1 (1904), p. 45, figs. Common throughout the state on soft maple and occasionally on hard and Norway maple but seldom in such numbers as to be injurious. The winged males and wingless females are quite common in September; the eggs being deposited in the crevices at the buds, or cracks of the rough bark of the smaller branches. First reported by Thomas.

[t] *Drepanaphis? minutus* Davis: Ento. News, Vol. 21 (May 1910), pp. 195–198, 1 pl. First reported by the writer.

[t] *Idiopterus nephrelepidis* Davis: Annals Ent. Soc. Amer., Vol. 2 (1909), p. 199, figs. Occasionally found in Chicago greenhouses attacking the tender unfolding fronds of the Boston and other ferns. It sometimes becomes abundant and destructive in poorly kept greenhouses, but where fumigation is regularly practiced they are easily held in check. First reported by the writer.

(To be continued)

Explanation of Plates 27 and 28.

Chaitophorus quercicola Monl.—Fig. 1, wing; 2, antenna of winged viviparous female.

Callipterous alni Fabr.—Fig. 3, head; 4, antenna; 5, wing; 6, cornicle; 7, style of winged viviparous female; 8, antenna; 9, hind tibia of wingless oviparous female; 10, antenna of winged male.

Callipterus coryli Goetze.—Fig. 11, head; 12, antenna; 13, wing; 14, cornicle; 15, style of winged viviparous female; 16, antenna; 17, hind tibia of wingless oviparous female; 18, antenna of winged male.

Calaphis betulella Walsh.—Fig. 19, head; 20, antenna; 21, wing; 22, cornicle; 23, style of winged viviparous female.

Camera lucida drawings, figures 3, 6, 7, 11, 14, 15, 19, 22, and 23 with one-inch eye piece and two-third objective; 2, 4, 8, 9, 10, 12, 13, 16, 17, and 18, with two-inch eye piece and two-third objective; 1, 5, 20, and 21, with one-inch eye piece and one and a half-inch objective.

THE COCCIDÆ OF AUDUBON PARK, NEW ORLEANS, LA.[1]

First Paper

By T. C. Barber, *Audubon Park Laboratory, Agent and Expert, U. S. Bureau of Entomology*

Audubon Park, New Orleans, is a particularly favorable locality for the development of plant and insect life. The climatic conditions are such that plants seem to thrive with equal facility whether they are transported from regions far to the north of Louisiana, or from as far to the south. Scattered through the park may be found representatives of almost all the common ornamental plants of the Northern States, while flourishing side by side with them can be seen hundreds of plants representing the native semi-hardy flora and plants imported from the semi-tropical regions of Mexico and Cuba. In one corner of the park may be found the huge Horticultural Hall, a relic of the Cotton Centennial Exposition of 1884. In this hall hundreds of species of tropical plants are found, which are carried through the comparative coldness of the Louisiana winters by means of artificial heat. Altogether, it is doubtful if many places can be mentioned where the observer is confronted by such a luxuriant and varied array of flora in a circumscribed area as can be found in this piece of land of less than 300 acres within the city of New Orleans.

The same conditions which make possible this diversity of plant growth, also make this spot an ideal one for insect development. With the exception of a few weeks of moderately cool weather in the winter, insect growth and multiplication is practically continuous the

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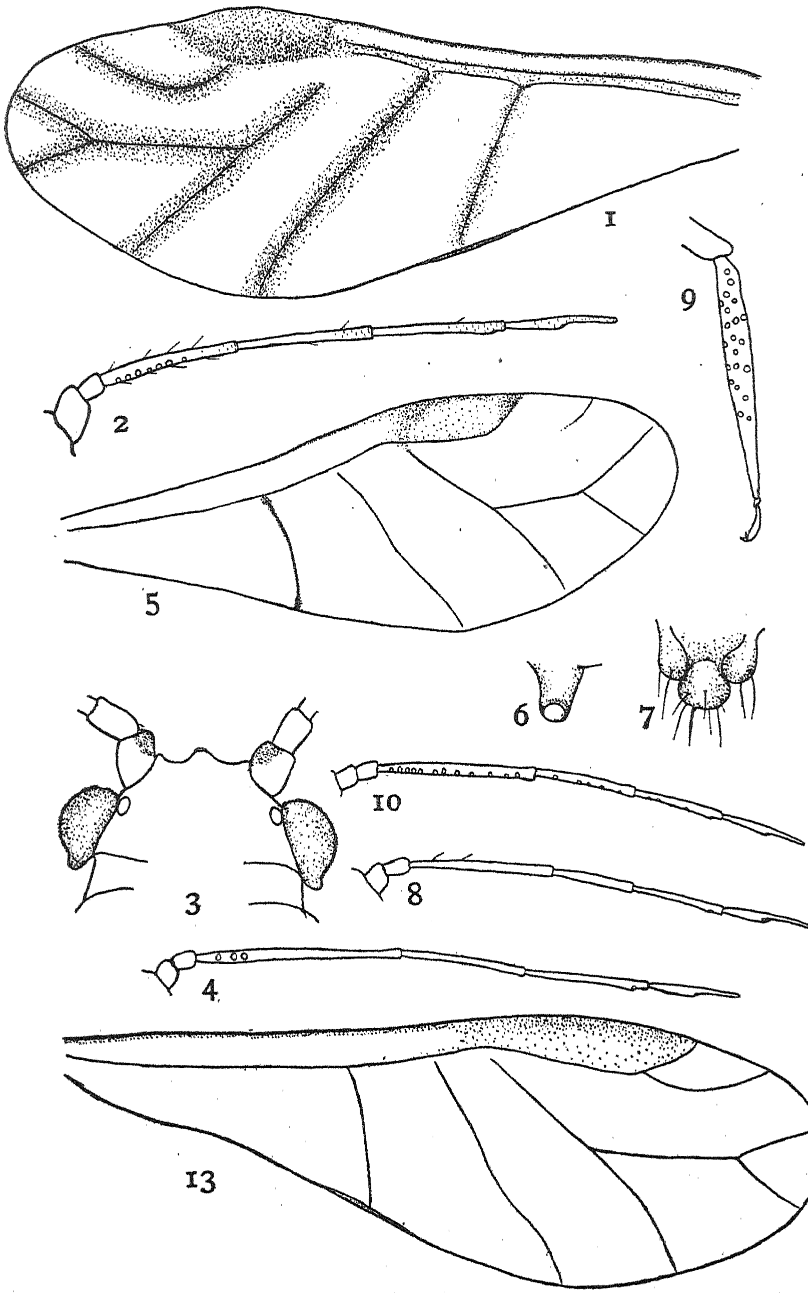
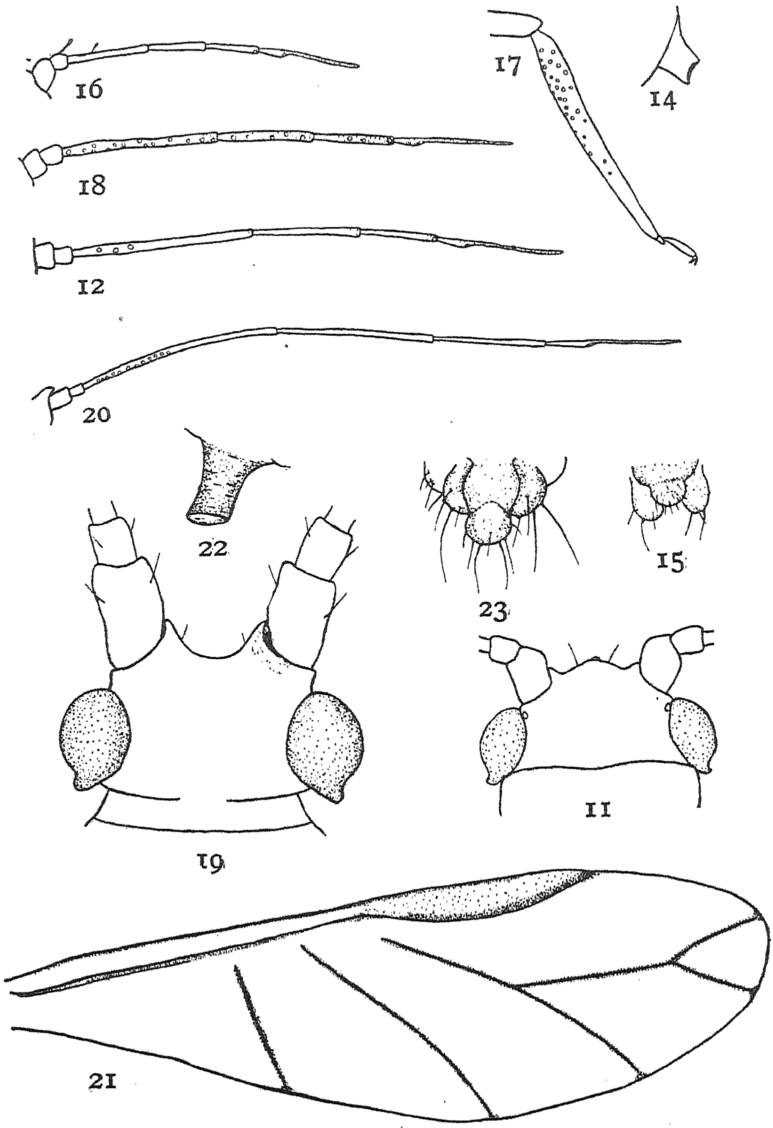
[1]Published by permission of the Chief of the Bureau of Entomology.

Plate 27



Structure of Aphididæ

Plate 28



Structure of Aphididæ

year round. The wide range of food offered by the large variety of plants, the humidity of the atmosphere, which tends to keep conditions at an optimum for both plant and insect growth, the small annual range of temperature, all result in the production of a large and varied insect fauna.

This is especially the case with the Coccidæ. These insects are for the most part so small and inconspicuous that they are easily introduced when importing foreign plants of every description. With the number of plants which have been imported into Audubon Park it would naturally be expected that a large number of scale insects would have been introduced with them, and this expectation is realized when one comes to examine the plants closely. Almost all the plants reveal the presence of one or more scale insects, and some of them can be found burdened with four or five species. Of course many of these scale insects are identical, that is, the same scale is often found on a large variety of plants, but even then, an unusually varied assortment may be noticed.

The excretions of scale insects and aphids form the chief food of the Argentine ant (*Iridomyrmex humilis* Mayr.) in the parks and squares where large numbers of plants abound, and the attention of the writer was first called to the number and variety of coccids by the vast numbers of these ants which can be seen assiduously attending them. The following list represents the more common species, but this can no doubt be added to extensively by going over the flora of the park more carefully and systematically than the writer has been enabled to do with the time at his disposal.

The species are arranged on the system followed by Mrs. Fernald in her "Catalogue of Coccidæ." The plants upon which they were collected are given a common name, as far as possible, but when no common name could be found, or where the use of the local common name would tend to cause confusion with different plants bearing the same common name in other localities, the scientific name is given.

The writer is deeply indebted to Messrs. J. G. Sanders and E. R. Sasscer of the Bureau of Entomology, for determinations of the large amount of material submitted to them through Dr. L. O. Howard at various times.

List of Coccidæ Collected at Audubon Park, New Orleans, La.

1. *Conchaspis angræci* Ckll. Collected upon *Icalpha miltoniana*, *Hibiscus sinensis*, *Acalypha sanderi*.

2. *Lecaniodiaspis* sp. Collected upon the fig.

3. *Pseudococcus adonidum* L. Collected upon coffee tree (*Coffea arabica*), jasmine, rubber tree (*Ficus elastica*), *Phyllanthus distiachus*, guava (*Psidium pomiferum*).

4. *Pseudococcus calceolariæ.* Mask. Collected upon the sugar cane, Johnson grass.

5. *Pseudococcus citri* Risso. Collected upon Croton, fig, orange, trumpet-vine (*Datura arborea*).

6. *Pseudococcus* sp. Collected upon hickory.

7. *Pseudococcus* sp. Collected upon Jamaica apple (*Anona cherimloa*).

8. *Pulvinaria cupaniæ* Ckll. Collected upon *Cupania sapida*, Calabash tree (*Crescentia cujetes*).

9. *Pulvinaria vitis* Al. Collected upon persimmon.

10. *Ceroplastes cirripediformis* Comst. Collected upon persimmon.

11. *Eucalymnatus tessellatus* Ckll. Collected upon *Caryota urens*, royal palm (*Oreodoxia regia*), *Wallichia caryatifolia*, *Rhapis variegatus*, *Phœnix* sp., rattan palm.

12. *Coccus hesperidum* L. Collected upon alligator pear (*Persea gratissima*), guava (*Psidium pomiferum*), *Malpighia glabra*, melon papaw (*Carica papaya*), banana, (*Musa cavendishi*), *Camellia japonica*, coral tree (*Erythrina cristi-galli*), cocoa tree (*Theobroma cacao*), Jamaica apple (*Anona cherimloa*), poinsettia, orange, *Ficus* sp., English myrtle.

13. *Neolecanium cornuparvum* Thro. Collected upon *Magnolia grandiflora*, *Magnolia fuscata*.

14. *Eulecanium corni* Bouche. Collected upon persimmon, swamp cypress.

15. *Eulecanium* sp. Collected upon sycamore.

16. *Saissetia hemisphærica* Targ. Collected upon coffee tree (*Coffea arabica*).

17. *Saissetia oleæ* Bern. Collected upon coral tree (*Erythrina cristi-galli*), golden dew-drop (*Duranta plumieri*).

18. *Diaspis bromeliæ* Kern. On pineapple.

19. *Diaspis boisduvalii* Sign. On *Phœnix reclinata*.

20. *Aspidiotus camelliæ* Sign. On *Magnolia grandiflora*, *Magnolia fuscata*, coral tree (*Erythrina cristi-galli*), evergreen thorn (*Cratægus pyracantha*), *Aralia paperifera*, China-berry, fig.

21. *Chrysomphalus dictyospermi* Morg. On *Rhapidophylum hystrix.*

22. *Aspidiotus hederæ* Vall. On sago palm.

23. *Aspidiotus lantaniæ* Sign. On alligator pear (*Persea gratissima*), guava (*Psidium pomiferum*), Loquat (*Photina japonica*), mulberry, asparagus vine, prickly palm (*Agrocomia mexicana*), juniper.

24. *Aspidiotus perniciosus* Comst. On pear tree.

25. *Cryptophyllaspis liquidambaris* Kot. On sweet gum tree.

26. *Chrysomphalus aonidum* Linn. The most abundant scale in the park. Some of the plants it was collected upon were banana (*Musa*

cavendishi), *Aralia chabrierii*, *Magnolia grandiflora*, orange, sweet olive, camphor tree, oleander, royal palm (*Oreodoxia regia*), date palm (*Phœnix reclinata*), prickly palm, (*Agrocomia mexicana*) screw pine, cocoanut palm, *Phœnix canariensis*, *Chamerops gracilis*, *Metrosideros* sp., *Aralia paperiferæ*, poinsettia, myrtle, etc.

27. *Chrysomphalus obscurus* Comst. On pecan.

28. *Odonaspis inusitata* Green. On bamboo (*Bambusa argentia striata*), Japanese bamboo (*Bambusa taisan chiku*).

29. *Odonaspis* sp. On Bermuda grass.

30. *Lepidosaphes beckii* Newn. On orange, *Citrus trifoliata*, *Camellia japonica*.

31. *Lepidosaphes gloverii* Pack. On orange.

32. *Ischnaspis longirostris* Sign. On *Elæis guineensis*.

33. *Parlatoria pergandei* Comst. On Croton, orange.

34. *Parlatoria proteus* Curt. On *Elæis guineensis*.

THE COCCIDÆ OF BOULDER COUNTY, COLORADO

By T. D. A. Cockerell

In the *University of Colorado Studies*, Feb., 1905, I published tables for the separation of all the Rocky Mountain Coccidæ known at that time. Not many have been added since, but we have now a fair list of species from Boulder County, which seems worth publishing. I have included in the list (marked with an asterisk), various species brought in with plants, and not in any sense members of the fauna. These are of interest as showing the way in which Coccidæ are carried about, and also as indicating sources of interesting material to those engaged in the study of the group.

Ortheziinæ

Orthezia lasiorum Ckll. and *O. olivacea* Ckll. Both common at Boulder in nests of *Lasius*.

I will take this opportunity to raise once again the question whether the *Coccus adonidum* L. is not an *Orthezia*. I so referred it in Proc. Phila. Acad., 1899, but Marchal (Ann. Soc. Ent. France, 1908, p. 226) considers it to be *Pseudococcus*, while actually quoting the description, in which appears the words, "*linea dorsalis longitudinalis elevata.*" Sanders, (Jour. Econ. Ent., 1909, p. 431) reaching the same conclusion as Marchal, or merely following him, even refers to the "good" Linnean description. As I had already said my say, I tried, but without success, to get a committee of entomologists to sit on this

question, which is of importance as affecting the name of a common pest. Could the Association of Economic Entomologists take it up?

MONOPHLEBINÆ

**Palæococcus rosæ* Riley and Howard. On a bunch of bananas in a grocery store in Boulder.

DACTYLOPIINÆ

Dactylopius confusus Ckll. Common on *Opuntia* at Boulder. Also at Salina.

Ceroputo lasiorum Ckll. Boulder, in nests of *Lasius*.

Phenacoccus cockerelli King. Boulder, found by Mr. L. C. Bragg on wild *Prunus*. The following measurements from this material are in microns: Antennal segments (1) 27, (2) 50, (3) 42, (4) 30, (5) 40, (6) 32, (7) 27, (8) 27, (9) 52. Middle leg; femur with trochanter, 195; tibia, 120; tarsus (without claw), 85.

Pseudococcus gutierreziæ Ckll. Boulder, on *Gutierrezia*.

P. roseotinctus T. and W. Ckll. Variety with third antennal joint longer than usual. Boulder, with *Lasius*, May, 1907.

Erium lichtensioides Ckll. Boulder, abundant on *Artemisia*. Also at Salina.

Trionymus nanus Ckll. Described from Boulder.

Ripersiella leucosoma Ckll. Boulder.

Ripersia fimbriatula Ckll. and King, *R. salmonacea* Ckll., *R. viridula* Ckll., and *R. confusella* Ckll. Boulder, with *Lasius*. The following notes were made on the male of *R. confusella*, variety, collected on Flagstaff Hill, March 28, 1910, with *Lasius americanus* (T. and W. Ckll.).

Male. Pale pink, eyes dark red; mesothorax darker than head and prothorax, no dark bands; legs rather dark; four long white caudal filaments, the outer much shorter than the inner; head seen from above obtusely triangular, widest behind the eyes; length of wing, 1326 μ.

The accompanying female was pale pink, elongate, with no evident lateral tassels; caudal bristles about 120 μ. It appeared to be in the penultimate stage.

COCCINÆ

I follow the Fernald Catalogue as to *Coccus*, but it is possible that a different interpretation may hold. At all events, the name *Coccus* should properly have been restricted to what we now call *Kermes*, following the plan of selecting the best-known *native, economic* species. Moreover *Coccus* is the ancient name of *Kermes*.

Physokermes concolor Coleman. On *Abies lasiocarpa*, Lake Eldora,

Plate 29

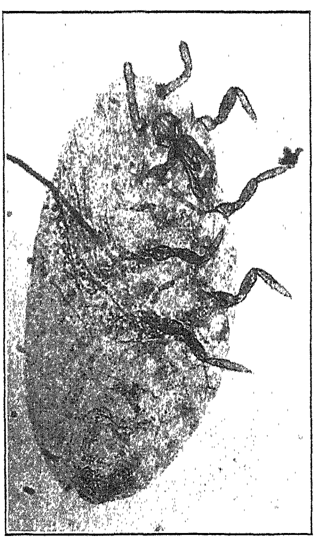


Fig. 1.

Fig. 2.

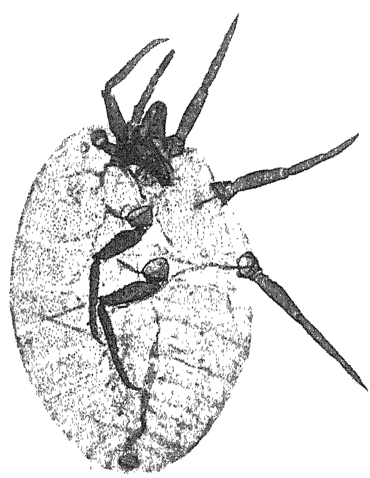


Fig. 3.

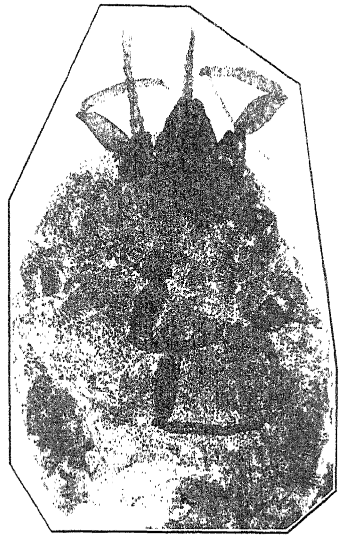


Fig. 4.

Structure of Coccidæ.

July 25, 1910 (E. Bethel). Smaller than *P. coloradensis*, the transverse diameter 5 mm. or less, color light fulvous brown. Coleman's description of his Californian insect on *Abies concolor* is too short, but doubtless our species is the same. *P. coloradensis* is probably confined to *Picea*.

**Eucalymnatus tessellatus* Sign. On a hothouse palm, Boulder.

Pulvinaria bigeloviæ Ckll. On *Chrysothamnus*, Boulder, June, 1910 (E. Bethel).

Eriopeltis coloradensis Ckll. Boulder is the type locality.

DIASPINÆ.

**Diaspis boisduvalii* Signoret. Boulder, on ferns in greenhouse.

Chionaspis pinifoliæ Fitch. Boulder canon, 7340 ft. on *Pinus scopulorum*. Also on Flagstaff Hill and at Salina.

Chionaspis bruneri Ckll. Boulder, on *Populus*. Preyed upon by *Chilocorus bivulnerus*. I use the name *bruneri* instead of *salicis-nigræ* (Walsh), because Walsh's species was never recognizably described, and the application of his name to the present insect is mere guesswork.

* *Hemichionaspis aspidistræ* Signoret. Boulder, on ferns in greenhouse.

Targionia graminella Ckll. On *Bouteloua oligostachya*. Found by Mr. E. Bethel at Boulder, and also at Leyden and Trinidad, Colorado. This species was discovered in New Mexico, and was considered extremely rare, but Mr. Bethel has found it abundant and destructive.

**Chrysomphalus aonidum* L. Boulder, on *Ficus* and palms in greenhouse.

**Aspidiotus hederæ* Vallot. Boulder, on trailing *Asparagus* indoors (Miss Olive Jones).

Aspidiotus ancylus Putnam. Boulder, on apple (D. B. Thurston).

A. juglans-regiae Comst., var. A few scales on the bark of a branch of wild plum, brought in for the *Phenacoccus*; Boulder, June, 1910 (Bragg). The material is scanty, and perhaps not quite typical.

**A. perniciosus* Comst. On Japanese quince shipped in, but not planted out, Nov. 1908 (T. B. Holman).

Explanation of Plate 29

Fig. 1. *Trionymus nanus* Ckll. on roots of grass under a stone. Boulder, Col., November, 1904.

Fig. 2. *Ceroputo lasiorum* Ckll. in nest of *Lasius interjectus*. Las Vegas, New Mexico, April, 1901.

Fig. 3. *Orthezia olivacea* Ckll. in nest of *Lasius* sp. Boulder, Col.

Fig. 4. *Orthezia lasiorum* Ckll. in the nest of *Lasius americanus*. Las Vegas, New Mexico, April 25, 1910.

Photographs from type slides kindly made for me at the Bureau of Entomology.

APPENDIX

Since the above paper was sent in, Mr. E. Bethel has sent me pieces of *Betula glandulosa* collected at Tolland on Aug. 26, plentifully infested with *Pulvinaria* and *Eriococcus*. Tolland is at an altitude of 8890 ft., which is very high for coccids; and while it is not in Boulder County, it is only a few miles south of the line.

The *Eriococcus* is unfortunately represented only by males, but the species is probably *E. borealis* Ckll., the only one known to occur at high altitudes. The *Pulvinaria* is represented by adults of both sexes, and is a very puzzling form of the *P. vitis* group. Provisionally I regard it as a variety of *P. occidentalis* Ckll.

Pulvinaria occidentalis var. *subalpina* n. var.

♀ Resembling *P. innumerabilis*, with the same sort of ovisac; scale very dark brown, hard to clear, 6.5 mm. long, 5.5 broad; marginal bristles 22–30 μ long, much more distant from one another than the length of one. Anterior tibia 180 μ, its tarsus (without claw) 85; claw stout, strongly curved; tarsal digitules quite stout, 55 μ long; claw digitules with large knobs, about 7 μ diameter. Antennæ 8-jointed, joints measuring in μ (1)67; (2) 67; (3) 100–102; (4) 67–75; (5) 67; (6) 35–40; (7) 30–32; (8) 57. Hair on first joint not very long; second with two bristles, one very long, fully 112 μ; third with one bristle, not very long; fifth with a very long bristle, 105 μ; sixth and seventh each with a short bristle; eighth with many, none very long. The immature female scales have a certain amount of thin glassy secretion on the dorsal surface.

♂ Head and mesothorax black (brown by transmitted light); neck reddish; prothorax dark red; abdomen dark reddish; legs and antennæ brown. Length about 1700 μ, excluding caudal filaments, which are about 1100 μ, and stylus, which is 405 μ; head small, 270 μ wide; wings 1530 μ long and 760 wide; anterior tibia 440 μ, its tarsus 200.

The glassy white male puparium, 2 mm. long, is as in *P. ribesiæ*, except that the posterior transverse lines or bands are continuous across the dorsum.

This male, compared with that of *P. ribesiæ*, as beautifully figured by Newstead, is seen to have the same coloration, but the caudal filaments are much shorter, and the anterior tibiæ are longer. In *subalpina* the fourth antennal joint (220 μ) is much longer than the fifth (150 μ), while in *ribesiæ* they are not far from equal. For the male of *P. vitis*, we have Signoret's figures. According to these *P. vitis* has the caudal filaments very long, as in *ribesiæ*, the fourth antennal joint also about as in *ribesiæ*, but the anterior tibia long as in *subalpina*.

P. innumerabilis male, as figured by Howard, has the caudal filaments relatively short, as in *subalpina*, but the fourth and fifth antennal joints are about equal and the tibiæ are rather short.

The female of *subalpina* seems to be distinguished by the relatively short tarsus and certain features of the antennæ. The hairs on the antennæ are practically as in *P. vitis* (as figured by Newstead), except

that those on the last joint are shorter, none longer than the joint itself. The antennal curve (based on the lengths of the joints) is nearly as in *occidentalis, ehrhorni* and *cockerelli*, but is not like *innumerabilis*, the third and fifth joints being much longer. (For *innumerabilis* I have two composite curves, based on 15 and 9 antennæ respectively, measured by King.)

I supposed at first that my insect would prove to be *P. innumerabilis betheli* King,[1] described from Colorado, and at first stated to be from *Betula*, but really from *Alnus*. This *betheli* form, however, really seems to be *innumerabilis*, and at any rate its special characters are not found in *subalpina*.

P. vitis verrucosæ King, found at Hamburg on *Betula verrucosa*, has the last antennal joint shorter, marginal hairs 40 μ, tibia 188 μ, and tarsus 96 (data from King). It does not appear to be our species. Mr. J. G. Sanders (Journ. Econ. Ent., Dec. 1909) has stated that *P. vitis, occidentalis* and *innumerabilis* are all one species. There is no doubt that his illuminating experiments throw much light on the variability of *P. innumerabilis*, and its adaptability to different plants. Indications of all this had been given by other writers, especially King (Psyche, May 1901), and it must doubtless be admitted that we have too many names in this group. Newstead treats *P. ribesiæ* as a variety of *vitis*, but nevertheless when he made experiments similar to those of Mr. Sanders, transferring the insects to twenty different plants, he met with no success, although the larvæ were seen to hatch. It thus appears that in the *P. vitis* groups there exist one or more very polyphagous species, and others which are virtually confined to one type of plant. The monophagous forms should no doubt be classed as true species, although they may very closely resemble the common widespread *vitis* or *innumerabilis*. As to the identity of *P. vitis* with *innumerabilis* and *occidentalis*, I am far from positively asserting that Mr. Sanders is wrong; but if he has data proving it, he he has not yet published them, and until he does so I am wholly unwilling to accept his dictum as final. Apparently these things have small but real distinctive characters, and I fear that in these and other instances there will be a tendency to "lump" uncritically, partly because it saves much trouble, and partly as a reaction against too much "splitting."

P. innumerabilis is common in Denver. If all the insects now discussed are one species, it is just possible that the eggs or larvæ were brought to Tolland by a bird, a distance of about 30 miles. I can hardly doubt, however, that *subalpina* is native, and if not a form

[1]*Pulvinaria innumerabilis betheli:* was described from "Colorado." I learn from Mr. Bethel that it was obtained on *Alnus tenuifolia* at Grand Lake, Middle Park.

of the northwestern *occidentalis* (surely not, if *occidentalis* is really to be united with *vitis*), then a distinct species. I use a varietal name here, as I have in many other cases, to indicate a form the taxonomic position of which is uncertain.

LIFE HISTORY NOTES AND CONTROL OF THE COMMON ORCHARD MITES TETRANYCHUS BIMACULATUS AND BRYOBIA PRATENSIS

By G. P. Weldon, *Grand Junction, Colorado*

Little is known about the wintering habits of the various species of mites belonging to the genus Tetranychus. It may be of interest to some of the readers of the Journal of Economic Entomology, if in this article a brief account is given of the hibernation of one of the more common species found in Colorado.

During the summer seasons of 1908, 1909 and 1910, *T. bimaculatus* has been of general occurrence throughout the orchard sections of the Western Slope of Colorado, and in many cases their numbers have become so abundant and their attacks so severe, that considerable injury to trees and fruit has been the result.

Hibernation of T. bimaculatus.—In the spring of 1908 a number of apple trees were banded with "tree tanglefoot" to trap the woolly aphis as it migrated from the roots to the branches of the trees. On April 27, quite a number of the above species of mite were found in the lower margin of a band, which indicated that they had hibernated in the soil close to the tree. During the early fall of the same year, Mr. O. B. Whipple, who was at that time Field Horticulturist of the Colorado Experiment Station, at Grand Junction, sent me some red mites of this species for identification, which he had collected on the ground where they had migrated in abundance from some peach trees, upon the foliage of which they had been feeding. During the summer of 1909, *T. bimaculatus* was very plentiful on orchard trees at Palisade, Colo., and I had an opportunity of observing the same thing. On August 9, the mites were found to be leaving the trees in great numbers. There were so many of them that the ground was literally red in places, and their silvery webs were everywhere to be seen. An examination of clods of earth in the orchard, showed that the mites had sought shelter beneath them, and they were found going into the soil at distances up to fully eight feet from the nearest tree. Upon breaking open small clods hundreds of the mites would often be found within. Webs were found in the little soil spaces, and a careful search

for eggs was made. The search resulted in not finding a single one. A large abundance plum tree, at the base of which myriads of the mites entered the soil in August, served as an observation place until October, when the work ceased until spring. On the 23rd of March the tree was again visited, and an examination of the soil near the crown was made for mites which it was thought had surely hibernated there over winter. Clod after clod was broken, myriads of the dead mites were found, and the search became discouraging. Finally a clod which was quite moist, and which had probably retained its moisture all winter, was broken into, and there in a tiny soil cavity was a nest of only half a dozen lively little red mites, which had survived through severe winter weather, at a depth of 1.25 inches beneath the surface of the soil. The striking fact that where millions had entered the soil in the fall, only a very few individuals survived, was attested by the tremendous lot of dead ones encountered during the search, and only a half dozen live ones. Truly it was a case of the survival of the fittest.

SUMMER HABITS OF T. BIMACULATUS.—This is the only species of *Tetranychus* that I have found feeding upon orchard trees. The close association of this species with *Bryobia pratensis* has made it very difficult for the orchardists to distinguish the one species from the other. *T. bimaculatus* has been commonly found in the orchards on apple, plum, prune, peach, pear, cherry and almond trees. Most of our shade trees seem subject to their attack, and small fruits are quite often severely injured. Especially have they been abundant on raspberry bushes, and some of the raspberry growers have attributed not only the failure of their fruit crop, but also the death of many bushes to the attack of this little pest.

The season during which this pest becomes serious is fortunately short. It is seldom that their injury becomes great until the hot weather of July, and while a few commence work quite early in the season, it is not usual to see them in great numbers until the excessive heat of midsummer accelerates their development. Often the orchardist is hardly aware of their presence until the latter part of July, when he suddenly notices the foliage of his trees turning yellow, and at this time he may also witness a wholesale migration of the little red pests to the ground, where every clod turned over reveals the hiding place for hundreds of them. Slowly they make their way into the soil to a depth of presumably never more than two inches, where conditions will probably be favorable for at least a few of them to survive the winter. On the 26th of July this season, the first downward migration of mites was noticed in two orchards near Grand Junction, and the soil for several feet on every side of infested trees was alive with them.

from these pests demands that something must be done to check their onslaught, either a dormant spray of lime and sulphur, or a summer treatment with flowers of sulphur will probably be found perfectly effective.

NOTES OF THE SEASON IN CONNECTICUT.

By W. E. Britton

The prevalence or absence of the various insect pests and their natural enemies varies greatly from year to year, and though observations regarding them may not possess great scientific value, nevertheless such records should be kept when possible, and if published in a periodical like the Journal, will show something of interest and value in the progress of the distribution of certain species and their fluctuation, or periods of serious injury and subsequent decline.

Aphids, which were generally abundant last year, have been comparatively scarce during the present season. Of course, some kinds are always present, but the rosy apple aphis, which did such serious damage in 1909, was almost wholly absent in 1910, and in some orchards much searching was necessary to find a single colony. In no instance did a case of injury from it come to my notice. Eggs of the 15-spotted lady beetle, *Anatis 15-punctata* Oliv., were extremely abundant on the trunks and branches of apple trees early in May, fifteen to twenty clusters containing altogether several hundred eggs, being often found on a single tree. It may therefore be assumed that this Coccinellid played a rôle of no mean importance in checking the depredations of the rosy apple aphis, but it was not the only natural enemy, as many of the aphids were parasitized late in 1909 by *Megorismus fletcheri* Cwfd., and syrphid and *Chrysopa* larvæ were abundant. The green apple aphis, *A. pomi* De G., was present both seasons in moderate numbers.

White grubs were destructive to grass lands in 1909, and June beetles were abundant early the following season, even defoliating trees in some sections of the state. Rose beetles were present in usual numbers, and caused the ordinary amount of damage in gardens and vineyards.

One characteristic of 1910 is the scarcity of sphinx larvæ, and nearly all those observed were strongly parasitized. Especially has this been true of the common tomato or tobacco worms, *Phlegethontius sexta* Johan. and *P. quinquemaculata* Linn, every caterpillar which we have taken showing before pupation the cocoons of *Apanteles congregatus* Say.

Canker worms, chiefly the fall species *Alsophila pometaria* Harr., were abundant, and their devastation was widespread throughout the state on many different kinds of trees.

Cut worms were especially troublesome in June, and much damage was reported to this office.

Sawfly larvæ of several unusual kinds were observed feeding upon plants not commonly attacked. The peach sawfly, *Pamphilius persicum* MacG., defoliated many trees in some of the large peach orchards, and though I have not learned of any attempt to check their ravages by spraying, some of the orchardists are now planning to spray their trees in 1911 with lead arsenate to prevent a repetition of the injury.

The result of the campaign against the gypsy moth colony at Wallingford has been most satisfactory, and through the efficacy of lead arsenate spraying and of tanglefoot and burlap bands the number of caterpillars was so greatly reduced that before the end of the season the combined efforts of a gang of fifteen men resulted in finding only a few examples during a week of careful searching. At the Stonington infestation good progress was also made, and though more caterpillars were taken than in 1909, the whole number might have been produced by a single egg-mass overlooked in scouting during the winter.

The brown-tail moth, *Euproctis chrysorrhœa* Linn., which has hitherto not appeared in Connecticut except on nursery stock imported from Europe, was found at Thompson in April, 1910, by some men who were engaged in pruning trees on a large estate. We sent men to the vicinity to investigate, and seven or eight pear and apple trees were found infested, and were at once sprayed with lead arsenate. Later some nearly full-grown caterpillars were discovered at Putnam. Both of these towns are in the northeast corner of the state, and the infestation is no doubt due to the natural spread of the pest, which for two or three years has been known to be near the borders of Connecticut in both Massachusetts and Rhode Island. A systematic examination must be made of this region after the leaves drop, combined with the destruction of all winter nests found.

During the past few weeks nearly all of the birches known as the white, gray, or bobbin birch, *Betula populifolia*, have been defoliated by the birch bucculatrix, *Bucculatrix canadensisella* Chamb., throughout the northern and eastern portions of the state. This insect, though a pest in northern New England and in certain seasons in Massachusetts and Rhode Island, has not during my residence of over sixteen years in Connecticut shown any such outbreak.

Other points worth noting in this paper are the increasing damage

to shade trees by the leopard moth, *Zeuzera pyrina* Linn., which is boring in the branches of various kinds of trees in the cities, and by the woolly maple leaf scale, *Phenacoccus acericola* King, which here confines its attacks chiefly to the sugar maple. The maple borer, *Plagionotus speciosus* Say, is still a serious pest of sugar maple shade trees in towns and cities, over sixty adults being taken by the gypsy moth men in Wallingford during their work of turning bands. Though this insect is not considered as a forest insect, the writer has seen its damage in wooded areas of perhaps twenty-five acres in extent in western Massachusetts and in New Hampshire.

The elm leaf beetle has done great damage in certain parts of the state, especially where the elms were not sprayed last season; but in New Haven, Milford, and other places where a systematic spraying of the trees was practiced in 1909, beetles have been rather scarce, though in most of these towns spraying has again been practiced this year.

Scientific Notes

BUCCULATRIX CANADENSISELLA CHAMB.—The work of this Tineid, which has this year been very abundant and destructive in many parts of New England, has been observed on the bir hes (*Betula populifolia*), throughout Rhode Island, up through Eastern Massachusetts, west as far as Springfield, Mass., and north to Manchester, N. H., and to about 12 miles west of Nashua, N. H. According to advices sent us by Captain Philbrook, it is present in Maine as far east as Augusta and he has also noticed it in Waterville. At Melrose Highlands, where it has been very common, the small white moulting cocoons of the larvæ were first noticed on the leaves of the birches on August 29. The pupal cocoons were first observed in the field September 9th, and on the 10th the larvæ, which had been abundant on the leaves a few days before, had almost all disappeared. As a result of the work of this insect, the leaves of the majority of the birches in the woods about here are prematurely dead, brown and shrivelled, and this condition has been reported from a great many localities throughout the infested area.

WILLIAM R. THOMPSON.

DISCUSSION AND CORRESPONDENCE

Food of the Bobwhite

I must protest against the undue praise given by Prof. C. F. Hodge to a paper[1] on the Food of the Bobwhite, published in the June number of The Journal. This account adds nothing to the publications by Dr. Sylvester D. Judd of the U. S. Biological Survey, except what is based on tests as to the choice of food by practically domesticated birds.

For many reasons feeding experiments with confined birds are useless as furnishing analogies to the conduct of individuals of the species under natural conditions. It is almost impossible wholly to remove the factor of human choice of the food. Moreover the usual change in amount of exertion by the birds, the absence of enemies, and other changed conditions make different impulses and behaviour almost unavoidable and certainly result in a different attitude toward food. There are no better illustrations of the effects of confinement than animals in zoölogical gardens. As is well known, very few of them get their natural diet and some, indeed, will not thrive on any thing like their natural food, or conversely, they do thrive on a regimen they never experience in nature. For instance, the anteaters and the solenodon in captivity subsist on hard boiled eggs. Is it not just as reasonable to draw an analogy here as in the case of quails fed clothes moths, mosquitos and house flies?

A few instances from records of feeding experiments by the Biological Survey will further show the fallacy of basing conclusions as to economic value on the behaviour of captive birds. A shrike willingly devoured a goldfish and a black bass; items of food it probably never gets in the wild state. A bluejay refused to eat acorns, dozens of which were found in collected stomachs; disdained beech nuts, another favorite natural food, and would not touch a live English sparrow nor a mouse, though both birds and mice have been found in the stomachs of wild birds. A caged bluebird refused the ground beetle, *Scarites subterraneus*, but wild ones eat it. English sparrows would not eat dandelion heads, though free birds are commonly observed rifling them of their seed. Bobwhites tested here refused plant lice; those tested by Mrs. Nice ate them freely. A confined song sparrow rejected

[1] Food of the Bobwhite. Margaret Morse Nice, Clark University, Worcester, Mass. With an introduction by C. F. Hodge. Journ. of Economic Entomology. Vol. III, No. 3. June, 1910. Pp. 295–313.

Diabrotica and *Hippodamia*; both have been revealed by examinations of the stomachs of wild birds. Perhaps the most surprising case is of a song sparrow refusing seeds of lamb's quarters, and smartweed, and finally only being starved into eating seeds of pigweed. Under natural conditions these are favorite foods.

Such instances clearly show the futility of experiments on confined birds in so far as learning food preferences is concerned. It will be readily admitted that such experiments are even more disappointing when data as to the quantity of food consumed by wild birds is desired. The only way to determine accurately the economic value of the various species of birds is to learn their relations to other organisms under the unmodified conditions of areas voluntarily inhabited by wild individuals. Experience has shown that the best, if not the only thoroughly reliable methods, are the analysis of authentic pellets, or fæces, or the contents of the crop, gizzard or other parts of the alimentary canal. Hence the paper under discussion, all original information in which is based on studies of captive birds, fails as a contribution to knowledge of the economic value of the bobwhite.

The fact that numerous names of weeds and insect pests were added to the list of seeds and insects found in collected stomachs by Judd is of no significance. Beneficial insects and cultivated fruits and grains could just as well have been fed to the birds and a directly opposite impression given. But in neither case would the result be a guide to the behaviour of the bobwhite under natural conditions. A knowledge of that behaviour, and that only, is of value in determining the economic status of a species.

W. L. McAtee.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The twenty-third annual meeting of this Association will be held at Minneapolis, Minnesota, during the Christmas holidays.

Active and associate members will receive further notice concerning the meeting and blanks will be sent so that the titles of papers can be entered and returned to the Secretary before the program is made up.

Foreign members should forward to the Secretary, at once, the titles of papers which they wish to present at this meeting and the manuscript should be mailed so that it will arrive on or before December 15, 1910. It is impossible at this time to furnish foreign members with the exact dates and hours when the sessions will be held but the Secretary will take pleasure in supplying, as promptly as possible, any information that will be of assistance to members who expect to be present.

A. F. Burgess, *Secretary, Melrose Highlands, Mass.*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

OCTOBER, 1910

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints may be obtained at cost. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—EDS.

The wide dissemination of scientific matter, particularly of an economic character, is highly desirable. There has been a gratifying advance along this line in recent years. This is especially true of the agricultural press. Late discoveries respecting insects and their part in the dissemination of disease has stimulated the demand for this type of information, and magazines of standing are giving considerable space to various phases of the work. We recently noted in one monthly of excellent standing, a caution respecting the admission of even a single fly into the house, the statement being made that such was very likely to result in a large multiplication and consequent abundance of the pest. The obvious inference from the context was that the flies multiplied in the house, and we have since been wondering in what section of the country the author resided. We have not been privileged so far to enter many American homes where flies would multiply indoors to any great extent, at least. About the same time another magazine published an excellent article on South African locusts or grasshoppers, accompanying it by a fine series of illustrations showing the transformations of our so-called 17-year locust or periodical Cicada. There was no direct statement to the effect that the illustrations represented an insect substantially identical with the South African locust, yet the lay reader would be justified in assuming such to be the case. Errors are to be expected in the daily and weekly press and are sometimes unavoidable in the presumably more carefully edited monthlies. Our popular magazines are doing an excellent work in giving much attention to practical or applied entomology and we feel that this should not be marred by such obvious errors as those cited above.

The proceedings of the annual meeting, assembled in early January, means an abundance of copy for the February and April issues, with possibly some papers read by title only being carried over to June. Notes for the year from various sections of the country are very useful records, and as a rule there should be little

difficulty in preparing such for publication in the October and December issues—numbers much less likely to be crowded with matter than the following two issues. One such paper appears in the current number, and it is to be hoped that there will be several in the December issue. Early publication should not operate to limit discussion, and in many instances would be of great value because of the opportunity for looking up doubtful points. We would also take this opportunity of calling attention to the importance of placing on record minor observations as Scientific Notes. Many of these, while small in themselves, mean a substantial addition to knowledge in the aggregate, and in altogether too many instances they are buried in a mass of notes or forgotten, often to the detriment of workers in allied lines.

Reviews

The New Mexico Range Caterpillar, by C. N. AINSLIE, U. S. Dept. of Agriculture, Bureau of Entomology, Bull. 85, Part V (1910), p. 59–96.

This admirable bulletin contains a full account of *Hemileuca oliviæ*, an insect which has been until recently very rare in collections, but has now appeared in immense numbers in northern New Mexico, the larvæ destroying the range grasses. The species belongs to a group of closely allied forms inhabiting principally the tablelands of Mexico, and probably all grass-feeders. Doctor Dyar has contributed a section on the taxonomy of *H. oliviæ*, giving full descriptions of all the stages, and a discussion of the related forms. The authorship of this section is stated in the introduction, but it should have been given also at the beginning of the section, where it would be noticed by bibliographers. The whole life history of the insect has been carefully worked out by Mr. Ainslie, and is very well worth reading for its biological interest. It is perhaps probable that *H. oliviæ* is a relatively recent segregate from the Mexican group, resulting from some migrant which possessed characters enabling it to successfully multiply far out of the range of the parent type. Even now the adjustment seems incomplete, for the moths emerge in the fall, and very many perish in the cold and snow. It was also ascertained that the heat of the bare ground is fatal to the larvæ; when placed upon it "only in rare instances did any survive when the distance to be traversed equalled 24 inches." Pupation takes place principally among the branches of a species of Compositæ, *Gutierrezia sarothræ*; and Mr. Ainslie notes that the overstocking of the range has reduced the nutritious grasses and led to the increase of this weed, which now greatly facilitates the spread of the *Hemileuca*, which in its turn further reduces the grasses.[1] Owing to this condition, it is impossible to say how widely the insect may spread, or how much damage it may do. Mr. Ainslie describes the defensive fluids of the moths, and remarks that it is curious that they should be so well equipped for defense against enemies which in New Mexico appear to be non-existent. He also notes

[1] However, as I noted from specimens sent to me by Mr. Frank Springer, the *Gutierrezia* is severely attacked by the Cecidomyiid *Rhopalomyia gutierreziæ* (Ckll.).

that while several hymenopterous and dipterous parasites were bred, the insect-parasition is quite low, about half a per cent. All this again may be indicative of migration from some other region.

On page 61 Mr. Ainslie states that "the first authentic history of the genus *Hemileuca* in New Mexico begins about five or six years ago." This is a very extraordinary statement, difficult to comprehend. Mr. Springer wrote me that the pest had been noticed in Colfax County for about ten years. The original *H. oliviæ* was described from Santa Fe, New Mexico, in Psyche, Aug. 1898. Later in the same year, also in Psyche (p. 298), the larva was briefly described and the grass-feeding habit noticed. *Hemileuca artemis* Packard, a *Populus*-feeding species, was described from Las Cruces, New Mexico, as early as 1893 (Proc. Amer. Phil. Soc., p. 172). *H. juno* Packard also occurs in the Mesilla Valley, but I think the record has not been published. *H. tricolor* Packard, 1872, is from New Mexico.

T. D. A. COCKERELL.

Report of the Field Work against the Gipsy Moth and the Brown Tail Moth, by D. M. ROGERS and A. F. BURGESS. U. S. Dep't. Agric., Bur. Ent. Bul. 87, p. 1-81, 1910.

American literature relating to these two species has increased greatly in recent years. The continuous spread of the gipsy moth and the wide dissemination of the brown tail moth has necessitated large appropriations in recent years, both on the part of infested Commonwealths and the Federal Government. The bulletin under consideration is an excellent summarized account of the work against these two species, it being particularly valuable because of the description of the improved methods now in vogue and the careful discussion of the problems involved in the future control of these species. The authors are to be congratulated upon having produced a bulletin which states the situation fairly and in a manner intelligible to all. We trust that this publication will be widely distributed, since it is very important that all citizens resident in the Northeastern United States, at least, should have authentic information respecting the work against these two dangerous insect pests.

Plant Bugs Injurious to Cotton Bolls, by A. W. MORRILL. U. S. Dep't. Agric., Bur. Ent. Bul. 86, p. 1-110, 1910.

This important publication summarizes our knowledge respecting a considerable number of the plant bugs affecting cotton and places on record a large amount of original information. The discussion of the Conchuela, *Pentatoma ligata* Say, a species which may destroy from 5 to even 30% of all the bolls in a cotton field, is exceptionally full and is based on Dr. Morrill's studies in northern Mexico and western Texas. It is a valuable, detailed account of one of our injurious Hemiptera. This bulletin is one of the incidental results of the extended investigation conducted by the Federal Bureau of the cotton boll weevil and other insect enemies of this staple crop. This publication is illustrated by an admirable series of figures.

The Codling Moth and How to Control it by Spraying, by E. DWIGHT SANDERSON. N. H. Agric. Exp't. Sta. Bul. 143, p. 61-106, 1909.

This is a summary account of the life history of this species, based in large measure upon the author's extended investigations. It is particularly interesting to the

economic entomologist on account of the data given, showing the increased spraying in New Hampshire during recent years. The summaries of reports from fruit growers in different sections of the state are undoubtedly of value, since such statements are frequently very encouraging to the orchardist. The excellent series of illustrations adds greatly to the value of this popular bulletin.

The Sorghum Midge, by W. Harper Dean. U. S. Dep't. Agric., Bur. Ent. Bul. 85, Prt. 4, p. 39-58, 1910.

This bulletin is an excellent, comprehensive account of *Contarinia sorghicola* Coq., a recently described species now recognized as an important enemy of Sorghum. The biological data is particularly interesting, since we know altogether too little respecting the life histories of the numerous American species of Cecidomyiidæ. Under remedial measures the author advises the destruction of Johnson grass and the seed heads of the first crop in connection with clean harvesting, the idea being to restrict breeding early in the season, either in wild plants or in the early crop, and thus prevent its becoming excessively abundant toward the end of the season. Small crops of seeds can easily be secured by bagging the heads. The admirable series of original illustrations adds greatly to the value of this publication.

Snout Beetles that Injure Nuts, by Fred E. Brooks. W. Va. Agric. Exp't. Sta. Bul. 128, p. 145-85, 1910.

This attractively illustrated bulletin gives in concise form the results of investigations of nut weevils extending over a series of years. The accounts, while popular, add much to our knowledge of these insects. The author gives references not only to the technical descriptions of the species described, but also to the more important papers treating of their biology. In addition to fumigation and the destruction of infested nuts, the author advises the cultivation of the soil for the purpose of breaking up the hiding places of these pests and thus exposing the larvæ and pupæ to the air and their natural enemies. His suggestion respecting the trapping of the beetles in dead leaves is most interesting and must prove of great practical benefit. The bulletin is well illustrated.

Three Snout Beetles that Attack Apples, by Fred E. Brooks. W. Va. Agric. Exp't. Sta. Bul. 126, p. 105-24, 1910.

This is a well illustrated, popular account of the plum curculio, apple curculio and apple weevil, species which have been responsible for several years past, for knotty and wormy fruit in West Virginia. The author states that in the past, sound fruit has often been the exception rather than the rule, and in many cases almost the entire crop has been next to worthless. The local data given by the author will be of great service in future studies of these important insect pests.

Ninth Report of the State Entomologist, 1909, by W. E. Britton. Conn. Agric. Exp't. Sta. Biennial Rept. 1909–1910. Prt. 4, p. 325–374.

This public document is exceptionally interesting to the economic entomologist because of the detailed information respecting the occurrence of the gipsy moth at Wallingford and the progress made in extermination. An earlier note in this issue, page 435, shows that the campaign against this pest has been exceptionally successful. Similar infestations are likely to be found in other parts of the coun-

try, and the experience gained by Professor Britton at Stonington and Wallingford will undoubtedly prove of much service in handling similar problems in other sections. The rosy apple aphis, *Aphis sorbi* Kalt, which was exceedingly abundant in Connecticut, is discussed in detail, technical descriptions being given of the various stages. Among other important insects noticed are the bud moth, *Tmetocera ocellana*, the leopard moth, *Zeuzera pyrina*, and the peach borer, *Sanninoidea exitiosa*, together with minor observations upon a number of injurious species. The value of this report is greatly increased by an admirable series of illustrations, especially those showing the characteristics of gipsy moth infestation.

Current Notes

Conducted by the Associate Editor

Mr. George G. Becker has been appointed assistant in Entomology at the Arkansas University and Agricultural Experiment Station at Fayetteville, Ark.

Professor Clarence P. Gillette has recently been appointed Director of the Agricultural Experiment Station at Fort Collins, Colorado, in place of L. G. Carpenter, resigned.

Dr. H. T. Fernald, State Inspector of Massachusetts, attended a meeting of Massachusetts Nurserymen at Boston, June 11th, when an organization was formed, to be known as the Massachusetts Nurserymen's Association. Several states now have such organizations and the result will doubtless tend to improve the condition of certain nurseries and encourage a reasonable interpretation of the inspection laws and regulations.

Professor R. S. Mackintosh, who has for several years served as Horticulturist of the Alabama Experiment Station, and has been in charge of nursery inspection and quarantine work, has resigned to accept a position in the investigation of peach culture problems at the Pennsylvania State College. His successor is Professor P. F. Williams, formerly assistant to Professor Mackintosh, and a graduate of the Massachusetts Agricultural College in the class of 1905.

Mr. W. S. Griesa, proprietor of the Mount Hope Nurseries, Lawrence, Kansas, has established, in memory of his father, the late A. C. Griesa, a research followship in entomology at the University of Kansas. Mr. H. W. Lohrenz, a graduate research student of entomology in the University of Kansas, has been appointed to this fellowship and began his work on the fifteenth of June.

At the first International Congress of Entomology held last month at Brussels, the Entomological Society of America was represented by Dr. W. J. Holland of Pittsburg, Pa., Professor Herbert Osborn of Columbus, Ohio, and Dr. Henry Skinner of Philadephia, Pa. The second International Congress will meet at Oxford in 1912 on the invitation of Professor E. B. Poulton.

Mr. W. C. O'Kane, Assistant Entomologist of the New Hampshire Agricultural Experiment Station at Durham, N. H., has been appointed Entomologist of the same Station in place of Professor E. D. Sanderson who resigned recently to become Dean of the College of Agriculture of the University of West Virginia, Morgantown, W.

Va. Mr. O'Kane will also be Professor of Economic Entomology in the New Hampshire College.

Mr. John A. Grossbeck, Assistant in the mosquito work of the New Jersey Agricultural Experiment Station at New Brunswick, N. J., resigned his position August 1st to accept a position as Assistant in the Department of Invertebrate Zoology of the American Museum of Natural History of New York City.

Mr. J. B. Garrett, Assistant Entomologist of the Agricultural Experiment Station at Baton Rouge, La., has been made Entomologist of the same station, succeeding Mr. Newell, who resigned to accept a position as State Entomologist of Texas. Mr. Newell's new position has already been noted in this Journal (see page 111).

L. M. Peairs, Assistant in Entomology at the Maryland Agricultural Experiment Station, has been appointed assistant entomologist of the Kansas Station.

Prof. C. H. Fernald of the Massachusetts Agricultural College, owing to the infirmities of advancing years, has retired from active work and has been appointed Honorary Director of the Graduate School. He has been connected with the institution for twenty-four years and a goodly number of our more promising, younger entomologists have received their preliminary training under his direction. His son, Prof. H. T. Fernald has been appointed Acting Director of the Graduate School and also succeeds his father as Entomologist of the Station.

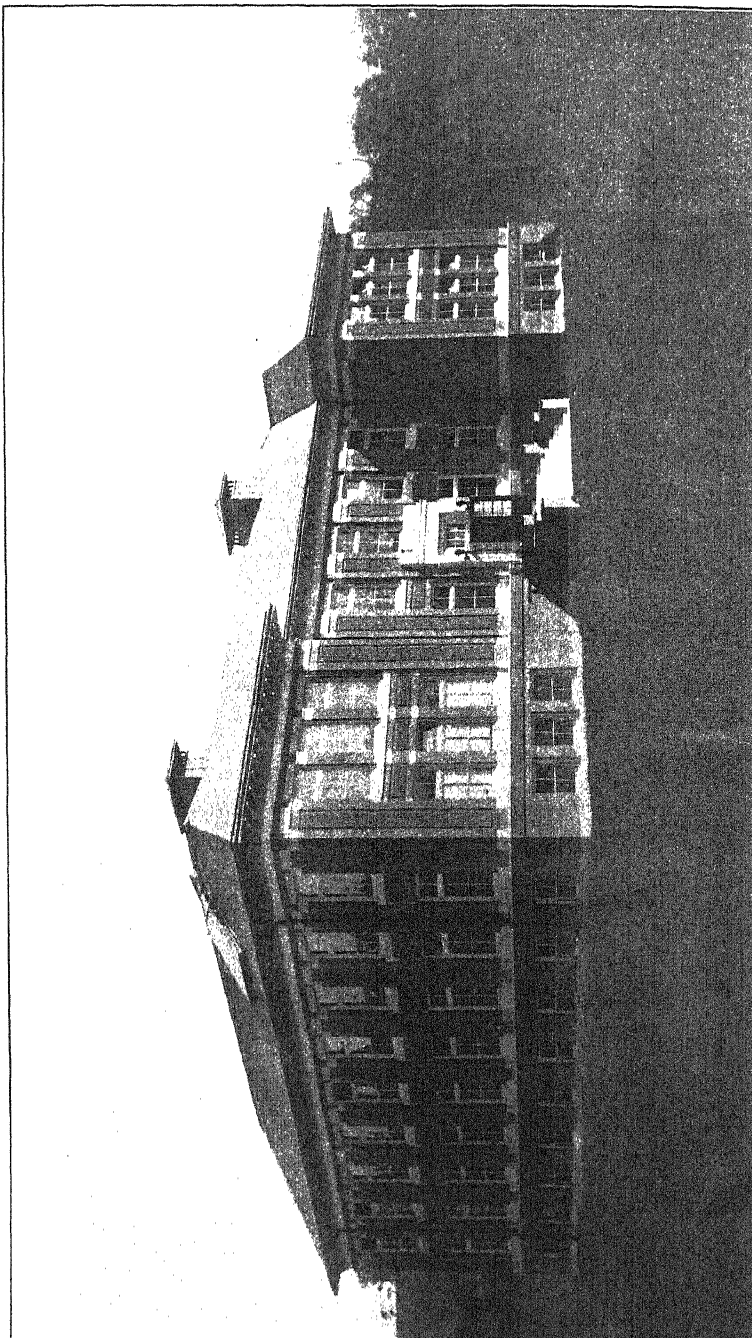
Dr. E. A. Bach has been appointed State Entomologist of Virginia and Entomologist of the Agricultural Experiment Station.

Dr. Burton E. Gates has been appointed to the newly established position of Assistant Professor of Bee Culture at the Massachusetts Agricultural College and State Inspector of Apiaries.

E. G. Titus, Entomologist of the Agricultural Experiment Station, Utah, is spending a year's leave of absence in special study at Harvard University.

Mailed, October 15, 1910.

Plate 30



New Building for Entomology and Zoölogy, Massachusetts Agricultural College.

JOURNAL

OF

ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 3 DECEMBER, 1910 No. 6

THE NEW ENTOMOLOGICAL BUILDING AT THE MASSACHUSETTS AGRICULTURAL COLLEGE

The new entomological building recently completed at the Massachusetts Agricultural College is a large and commodious structure. It is placed on the eastern side of the campus, facing the west, and consists of two stories, basement and attic. It is constructed of brick and stone with a steel frame, cement floors and slate roof, and is considered to be entirely fireproof.

The building is in the form of an H, the cross bar being carried toward the front, thus giving a central building and north and south wings. The central portion in front is devoted to offices, supply rooms, and a library on the second floor. Behind, is an amphitheater rising from the basement and accommodating about 180 persons. Above this, on the second floor is the insect room, 20 by 40 feet, and a filing and stenographer's room. The north wing contains the zoölogical laboratory and a room for microtomy on the first floor, and the senior and graduate entomological laboratories on the second floor. In the south wing are the zoölogical museum, and three rooms for the entomological work of the Experiment Station, one of which is connected with the greenhouse for experimental work on insects. On the second floor of this wing are the gallery of the museum, an advanced lecture room, accommodating 60 persons, and a graduate laboratory for zoölogy. In the basement, besides the amphitheater, are rooms for determinative mineralogy and geology, for the rock collection, a pump and apparatus room, an insecticide analysis room, and toilet and fan rooms. In the attic are rooms for photography and developing, a storage room and the janitors' quarters.

The senior entomological laboratory is 28 by 72 feet and has tables for 75 students, and the graduate laboratory will accommodate twenty.

The building is lighted by electricity and heated by steam from the central heat and light plant of the college.

The building was constructed from an appropriation of $80,000 for its erection, and $15,000 for equipment, this sum also including equipment in zoölogy.

Though entomology, zoölogy and geology are at present located in the building, it is understood that when the growth of the subjects requires it, the last two will be transferred to other quarters, leaving this as the Entomological Building.

The equipment in entomology includes microscopes, microtomes, and all the other apparatus usually required for such work, and an unusually full supply of books, journals and literature.

The dedicatory exercises were held November 11, and consisted of an address by Dr. W. E. Hinds of the Alabama Polytechnic Institute on the history of the Departments of Entomology and Zoölogy at the college, and the Dedicatory Address by Dr. L. O. Howard of the U. S. Bureau of Entomology.

H. T. Fernald.

[We understand that the excellent address by Doctor Hinds will shortly be published by the Massachusetts Agricultural College, while the admirable résumé of the development of entomological work in this country by Doctor Howard appeared in full in the issue of *Science* for December 2, 1910.—Ed.]

SCUTELLISTA CYANEA MOTSCH.

By H. J. Quayle, *Southern California Laboratory, Whittier*

Scutellista cyanea Motsch. is the most important insect enemy of the Black Scale (*Saissetia oleæ* Bern.) in California. This insect was introduced into the state in 1900 by the U. S. Department of Agriculture through Dr. L. O. Howard of the Bureau of Entomology. It is now well distributed in all parts of the state where the black scale occurs in injurious numbers. The percentage of scales parasitized also runs very high, amounting in many cases to 75 or 80%. But this varies greatly in different sections and in the same section in different years.

In spite of the frequently high parasitization by Scutellista, the

black scale still remains the most important citrus insect pest in the state. Taking the citrus belt over, more control work is directed against the black than any of the other scale pests. And, with all this control work, according to a statement by G. Harold Powell of the Bureau of Plant Industry, in 1908, from ⅓ to ½ of the oranges of California were washed because of the sooty mold fungus resulting from black scale infestation.

While, therefore, this parasite is well distributed, and the percentage of scales attacked is often large, as parasitization goes, yet, from a commercial standpoint, at least, the Scutellista is not often a very important factor in the control of the scale. Of course, in many places the Scutellista may not be abundant enough to check the scales. But again where they are most numerous the scale continues to thrive. There is not, therefore, necessarily a direct relation between the abundance of the parasite and the scarcity of the scale. It is not unusual to find the greatest parasitization where the scales are most abundant; and, again, where the scales are scarce there may be very few Scutellista. This might be answered by the fact that the Scutellista being an egg parasite affects only the progeny, and that the scarcity of scales should be attributed to the abundance of the parasite during the previous year. This may sometimes be the case, but there are often other and less tangible factors at work.

Many have been accustomed to judge of the efficiency of the Scutellista on the basis of the number of scales with exit holes, but this is not the only criterion. Since the Scutellista is an egg parasite, the real test of its efficiency is in its ability to prevent young from appearing. It might seem that this is directly related to the number of exit holes in the parent scales, but this is not necessarily so. A black scale may lay from 300 to nearly 3,000 eggs, the average number being from 1,500 to 2,000. A Scutellista larva will mature on the minimum number of eggs, but, if they are available, it will of course consume many more. But the Scutellista larva often does not consume the maximum number of eggs, so that in large healthy scales there may be several hundred young that will appear in spite of the presence of Scutellista larva. It is because of this failure to consume all of the eggs, in the case of the larger scales, and the fact that from each one of the 10, 15 or 25% of the scales not parasitized, there may appear 2,000 or more young, that a tree may continue to be badly infested, notwithstanding the large number of scales with exit holes. This may explain why more than 700 young black scales were counted on a single orange leaf growing from a twig that had 75% of the parent scales parasitized by Scutellista. On the other hand, where the scales are small or of medium size, the Scutellista consumes all of the eggs,

and must be an important factor in reducing the numbers for the succeeding year.

Since the Scutellista is generally distributed throughout the citrus belt of Southern California, little can be gained by turning loose a half dozen specimens in a grove of 10, 20 or 40 acres where there are already many hundreds or thousands, except for the moral effect on the grower. Sometimes the scale may largely disappear the following year, and sometimes the Scutellista may be a great help in this decrease, but in such cases it is on account of those already present in the grove rather than the supposed great impetus given by the half dozen introduced. Of course the artificial introduction of Scutellista in places where they do not occur, or are not well established, should be greatly encouraged.

The good that might result from the introduction of Scutellista is often rendered negligible because the scale is not in the proper stage to be attacked. With such introductions in most places in southern California during July and August, or even later of this year, nothing was left for the Scutellista but to perish. At this season all the eggs, or nearly all, had hatched and the parasite will not oviposit on the young scales. This is true also of those already present in the grove and hundreds or thousands must perish unless they find some scale out of season with those that have been attacked. Indeed, this is the most serious matter in the whole Scutellista economy and is a great drawback to their rapid multiplication. This parasite was hardly intended to depend, exclusively on the black scale, where there is a uniform hatch of the insect. Fortunately in most parts of California, and possibly other places where the black scale occurs, there are enough of the so-called "off hatch" to maintain the parasite until the bulk of the scales are in the proper stage again.

Life History and Habits

The egg is pearly white in color, ellipto-cylindrical in shape, with tapering appendage at one end. The length of the body of the egg is about .37 mm. and the appendage about one half that length. The eggs are inserted beneath the scale, usually under the arch at the posterior end. The scale need not necessarily be in the egg stage, for eggs have been found both in the field and insectary under scales that had not yet reached the egg-laying stage. The hatching period during the summer months is 4 to 6 days.

The young larva upon hatching soon begins to feed on the eggs of the scale by sucking out their contents, or, if eggs are not present, it attacks the insect itself. Several cases have been observed where

the larva had grown to considerable size under a scale that had not yet laid eggs. It is not, therefore, strictly an egg feeder, as generally supposed, but of course eggs constitute the normal food. Larvæ have been reared from the Soft Brown scale (*Coccus hesperidum*) in which cases no eggs were consumed for this scale lays no eggs. Larvæ have also been seen feeding on others of its kind. This cannibalistic habit must be rather common for in nature cases must often occur where several eggs are deposited under the same scale. This is not usually done by the same insect but by different individuals, as explained later.

The full grown larva preliminary to pupation hollows out a cell in the old egg skins and mats them together more or less with a small amount of silk. Strands of silk are also frequently, or usually, spun from the twig to the inner edge of the scale. Whether this is done in an effort to enclose itself on all sides with a small amount of silk, or whether it is an instinctive provision to assure the old scale adhering to the twig during pupal life, or both may only be conjectured. But it is a common conclusion that old scales harboring Scutellista pupæ are not lifted from the twig so readily as those not parasitized. Black scales that have been parasitized by Scutellista are more likely to remain longer on the tree than those that are not. These may remain on the tree for two or three years in many parts of Southern California where there is but little rain or wind to dislodge them. This fact is not often taken into consideration in estimating the amount of parasitization, so that those scales with exit holes increase with each year's infestation, while those without exit holes are more likely to drop off.

The amount of food consumed or the number of eggs of the scale necessary to bring the larva to maturity varies greatly. A scale has not yet been found too small to have a Scutellista pupa. The smallest mature black scale has been found to be less than one half the size of the largest. The smallest may have a maximum of 500 eggs and the largest from 2,700 to 3,000. The size of the mature larva varies greatly, according to the abundance of eggs, and likewise the adult. Males, of course, are much smaller than the females and there seems to be a preponderance of males in the smaller scales. No eggs hatch in the case of the smaller numbers of eggs, but several hundred may hatch in the case of the larger numbers. The length of the larval period varies from 16 to 21 days during the summer season.

The mature larva is white in color, with the darker gray of the digestive tract showing through the body wall in some of the specimens. The average size of the full grown larva is about 3 mm. and the width about 1 mm. It is broadest at the head end, while there

is a gradual tapering toward the posterior end. The external mouth parts consist of a pair of sharp pointed chitinous hooks which are used for piercing the egg shell or the body wall of the scales.

The pupa is almost jet black in color, having changed very quickly from that of the white larva. The length of the pupa varies from 1.5 to 3 mm. The large scutellum extends to the posterior margin of the second abdominal segment. The duration of the pupal stage is from 16 to 19 days. The most usual number under a single scale is one, but not infrequently two are found, more rarely three, and in but one case out of several thousand scales lifted, four pupæ were found in four separate cells beneath a single scale.

The adults upon transforming from the pupa eat out a round hole usually on the dorsal surface of the scale. They may remain a short time beneath the scale before emerging, since occasionally upon lifting a scale the mature insect will be seen to escape. They have been observed to oviposit within 24 hours after emerging. The ovipositor is inserted almost invariably under the arch at the posterior tip. Sometimes two or three insertions are made and the egg deposited, all within about half a minute. Oviposition has been observed to occur under scales from which all the eggs had hatched, under scales already occupied by Scutellista larva, under scales where not enough eggs remained to bring the larva to maturity, and where the young had hatched but died before emerging. In the field oviposition has been noted where the scales had not yet reached the egg laying stage, the so-called "rubber stage," and in the laboratory under forced conditions it has occurred on scales after the first molt. Oviposition has not been observed, even under laboratory conditions, in the case of very young scales. Several eggs may be laid in succession but these under different scales. Other individuals will lay eggs under these same scales and this probably accounts for two or more larvæ under the same scale.

Mr. E. W. Rust of this laboratory has apparently determined that this insect may reproduce parthenogenetically. Mature black scales with eggs were allowed to remain for a week under cover in order to allow any chance for Scutellista eggs that might be present to hatch. In the meantime several pupæ were put each in a separate box and the adults allowed to mature. Two of these unfertilized females were placed in a vial containing a twig with a single black scale. Several days later the scale was lifted and two Scutellista eggs and four newly hatched larvæ were found. Since the eggs hatch in from 4 to 6 days, the eggs and larvæ present must have come from the Scutellista liberated. Parthenogenetic reproduction is not necessarily common for the number of the sexes is approximately equal, and often even a slight excess in favor of the males.

The length of the adult life is from 9 to 12 days. Adults died within this period whether they were confined in a pill box with no food, or under practically natural conditions. Thus far they have not been seen feeding. It is possible that they feed on the surface tissue of the orange or something else, but this has not been observed. But that little food, if any, is taken in the adult stage seems likely, from the fact that the adult life is the same whether confined without food or in the presence of its probable food supply.

The stages and abundance of Scutellista are very much dependent upon the same conditions in the scale. Since the black scale is at the height of egg laying in this section in June, it is then that Scutellista larva or pupa will be most abundant. The period of greatest emergence of adults is during July. Many fail to lay eggs at this time because the scales are too young. It is necessary to find a scale out of season with the ordinary brood which developed the Scutellista in order for eggs to be deposited and the species perpetuated.

The number of broods in a season is not well defined. One record from egg to adult will serve to indicate the length of life and duration of the different stages. Egg laid July 22; egg hatched July 27; pupated August 12; adult emerged August 26; adult died September 4. The egg period is thus 5 days, larval 16, pupal 15, adult 9, or a total of 45 days for the life cycle from the egg to the death of the adult. If the scale were in the proper stage at the end of each generation there would appear from 3 to 4 generations of the parasite during the summer months, that is from May to September inclusive, and there may be 2 or 3 generations also during the winter season, but on account of the unfavorable conditions of the scale 4 or 5 will probably be nearer the actual number.

ON SOME PHASES OF PARASITISM DISPLAYED BY INSECT ENEMIES OF WEEVILS[1]

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In a recent article Mr. W. F. Fiske[2] has defined a certain phenomenon as superparasitism, which has hitherto been recorded by the present writer as accidental secondary parasitism.[3] In defining this

[1]Published by permission of the Chief of the Bureau of Entomology.

[2]W. F. Fiske, Superparasitism: An Important Factor in the Natural Control of Insects. Journ. Econ. Ent., Vol. 3, pp. 88–97, February 15, 1910.

[3]W. D. Pierce. Studies of Parasites of the Cotton Boll Weevil, U. S. Bur. Ent., Bul. 73, p. 33, January 21, 1908.

phenomenon, Mr. Fiske has performed a signal service. It seems worth while to present some concrete examples which have come to the notice of the writer, in order to make this interesting phase of parasitism more widely understood. Brief perusal of the records of the Southern Field Crop Insect Investigations seems to show the existence of a number of important phases of superparasitism in addition to those brought out by Mr. Fiske's work on the gypsy moth parasites.

An effort has been made to classify the various examples which have been gathered in such a manner as to show in how many ways the parasites may interact upon each other, even in as simple a parasite problem as the boll weevil presents. There are many other branches of entomological research where parasite conditions are far more complicated than in the instances herewith cited.

Insect parasitism of weevils may be classified as follows:

1. Primary	Simple	Endoparasitism
		Ectoparasitism
	Multiple	Endoparasitism
2. Secondary	Hyperparasitism	
	Superparasitism	

These different phases may therefore be defined in couplets.

Primary parasitism is an original parasitic attack upon a host.

Secondary parasitism covers all subsequent attacks by parasites.

Simple parasitism is the attack by a single individual.

Multiple parasitism is the normal simultaneous attack by a number of individuals of the same species. It is probably the result of polyembryony in many cases.

Endoparasitism is the internal attack of a parasite.

Ectoparasitism is the external attack of a parasite.

Hyperparasitism is the normal attack of a parasite species upon another parasite species.

Superparasitism occurs when a normally primary parasite attacks a host already parasitized, and the result is that the latest comer generally attacks its predecessor.

Predation complicates parasitism many times and in fact brings about the same results as superparasitism; in other words, a struggle between forces working for the same end — the control of the host.

The following examples have been collected to illustrate each of these phases or their combinations:

Simple ectoparasitism is the commonest phase of parasitism upon external feeding weevils. Some of these parasites are quickly fatal while others are much less so. *Bracon mellitor* Say, *Catolaccus* sp.,

Cerambycobius sp., *Eurytoma tylodermatis* Ashmead and *Microdontomerus anthonomi* Crawford are normally primary ectoparasites, attacking weevils which do not enter the ground, their attack being fatal in a very short time. *Sigalphus zygobaridis* Crawford attacking *Zygobaris xanthoxyli* Pierce, *Sigalphus curculionis* Herbst attacking *Conotrachelus* sp., and probably *Eutrichosoma albipes* Crawford attacking *Auleutes tenuipes* Dietz and *Smicronyx tychoides* LeConte, are normally primary ectoparasites, attacking weevils which enter the ground for pupation, and do not kill the host until it has formed its earthen cell.

Averted simple ectoparasitism: Sometimes it happens that two different kinds of insects live in the same plant in a similar manner as *Anthonomus squamosus* LeConte and the fly, *Rhagoletis grindeliæ* Coquillett, in heads of *Grindelia squarrosa nuda*. An instance of averted parasitism occurred in the attack of this fly by *Eurytoma tylodermatis*.

Simple endoparasitism is not very common on the weevils which have been studied. The solitary hidden eggs of most weevils do not invite extensive parasitic attack; however, Girault has recorded *Anaphoidea conotracheli* Girault from eggs of *Conotrachelus nenuphar* Herbst, and *A. sordida* Girault from eggs of *Tyloderma foveolatum* Say. The larvæ are more frequently attacked. Among weevil parasites endoparasitism is displayed by *Myiophasia ænea* Wiedemann, *Ennyomma globosa* Townsend in the Tachinidæ, and by *Tetrastichus hunteri* Crawford in the Chalcidoidea, all attacking the boll weevil. Weevils of the genus Conotrachelus are attacked by *Cholomyia inæquipes* Bigot, *Metadexia basalis* Giglio-Tos, and *Myiophasia ænea* Wiedemann. The latter parasites are therefore forced to dig their way to the surface of the ground.

Multiple endoparasitism is probably the result of polyembryony in the following cases which are the only instances of multiple parasites of weevils known perfectly to us; viz., *Horismenus lixivorus* Crawford attacking *Lixus scrobicollis* Boheman, and an undescribed Tetrastichus attacking *Orthoris crotchii* LeConte. The number of Horismenus bred from a single host was very variable, being sometimes as high as 47. In both cases the parasites are internal and leave the host to pupate.

True hyperparasitism is at present unknown in the studies of weevil parasites.

Non-fatal superparasitism will be seen by the examples rendered to be much less common than the fatal. It displays several very peculiar phenomena.

In the following examples two primary simple ectoparasites, not always being of the same species, have successfully bred from a single host.

2 *Bracon mellitor* Say — 1 example.
1 ♀ *Catolaccus incertus* Ashmead, 1 ♀ *Cerambycobius cyaniceps* Ashmead — 1 example.
1 ♂ 1 ♀ *Cerambycobius cyaniceps* Ashmead — 2 examples.
2 *Cerambycobius cyaniceps* (from Lixus) — 1 example.
2 ♀ *Microdontomerus anthonomi* Crawford — 1 example.
2 ♂ *Microdontomerus anthonomi* Crawford — 1 example.
1 *Glyptomorpha rugator* Say and 1 *Cerambycobius cyaniceps* Ashmead (from Lixus) — 1 example.

An example is at hand of the breeding of two species of multiple parasites from the same host:

7 *Aphiochæta fasciata* Fallen, 2 *Aphiochæta pygmæa* Zetterstedt — 1 example.

COMBINED SIMPLE ECTO- AND MULTIPLE ENDOPARASITISM is a most peculiar phase of superparasitism.

From *Lixus scrobicollis* parasite records we obtain the following interesting records in this category; in each example all survive:

Numerous *Horismenus lixivorus* Crawford and 1 *Cerambycobius cyaniceps* Ashmead — 2 examples.
Numerous *Horismenus lixivorus* Crawford and 1 *Neocatolaccus tylodermæ* Ashmead — 1 example.
Numerous *Horismenus lixivorus* Crawford and 1 *Eurytoma tylodermatis* Ashmead — 2 examples.
8 *Horismenus lixivorus* Crawford and 1 unknown — 1 example.
47 *Horismenus lixivorus* Crawford and 1 *Cerambycobius cyaniceps* Ashmead — 1 example.

CANNIBAL SUPERPARASITISM: It frequently occurs where parasitism is high that the duplication known as superparasitism becomes a *normal* phenomenon. The females of a given species may repeat oviposition in the same host which they have themselves formerly attacked, or which another individual has attacked. With normally solitary parasites superparasitism is then inevitable, and the second comer usually devours the first. We have a record of a boll weevil larva bearing a dead fully grown parasite larva, which bore a dead half-grown larva, which in turn bore a minute living larva, and on another part of the dead host was another minute larva which would ultimately have a struggle with the first. The egg shells present proved them all to be conspecific.

In most cases of cannabalism both individuals die but we have the following records in which one survived:

2 *Bracon mellitor* Say, 1 ♀ survives — 1 example.
2 ♂ *Cerambycobius cyaniceps* Ashm., 1 survives — 1 example.
2 *Eurytoma tylodermatis* Ashm., 1 ♀ survives — 1 example.
7 *Eurytoma tylodermatis* Ashm., 1 ♂ survives — 1 example.

The following examples in which all died show how much duplication of energy there frequently is:

2 *Catolaccus hunteri* Crawford — 7 examples.
3 *Catolaccus hunteri* Crawford — 2 examples.
4 *Catolaccus hunteri* Crawford — 1 example.
5 *Catolaccus hunteri* Crawford — 1 example.
2 *Catolaccus incertus* Ashmead — 3 examples.
3 *Catolaccus incertus* Ashmead — 1 example.
4 *Catolaccus incertus* Ashmead — 2 examples.
5 *Catolaccus incertus* Ashmead — 1 example.
6 *Catolaccus incertus* Ashmead — 1 example.
2 *Eurytoma tylodermatis* Ashmead — 7 examples.
3 *Eurytoma tylodermatis* Ashmead — 2 examples.
5 *Eurytoma tylodermatis* Ashmead — 1 example.
2 *Microdontomerus anthonomi* Crawford — 1 example.
3 *Microdontomerus anthonomi* Crawford — 1 example.
4 *Microdontomerus anthonomi* Crawford — 2 examples.
8 *Microdontomerus anthonomi* Crawford — 1 example.

Mixed superparasitism is that phase in which two or more species are brought together upon the same host. The following records will show how common it is among parasites of the boll weevil.

We have many cases with only two parasites involved in which one individual survived. The sex of the survivors and the number of examples are given at the end of each line:

Unknown super. *Catolaccus hunteri* — 1 example.
Bracon mellitor super. unknown — 1 ♀.
Catolaccus sp. super. *Bracon mellitor* — 1 ♀.
Catolaccus hunteri super. unknown — 1 ♀.
Catolaccus hunteri super. *Bracon mellitor* — 1 ♀.
Catolaccus incertus super. *Bracon mellitor* — 2 ♀.
Cerambycobius cushmani super. *Bracon mellitor* — 8 ♂ (7), 9 ♀.
Cerambycobius cyaniceps super. unknown — 1 ♂.
Cerambycobius cyaniceps super. *Bracon mellitor* — 23 ♂ (6), 28 ♀.
Cerambycobius cyaniceps super. *Catolaccus hunteri* — 2 ♂, 2 ♀.
Cerambycobius cyaniceps super. *Catolaccus incertus* — 1 ♂, 3 ♀.
Eurytoma tylodermatis super. unknown — 1 ♂ (3), 2 ♀.
Eurytoma tylodermatis super. *Bracon mellitor* — 8 ♂ (2), 2 ♀.
Eurytoma sp. super. *Bracon mellitor* — 1 ♂.
Microdontomerus anthonomi super. unknown — 1 ♂, 1 ♀.
Microdontomerus anthonomi super. *Bracon mellitor* 4 ♂ (3), 14 ♀.
Microdontomerus anthonomi super. *Catolaccus hunteri* — 1 ♀.
Microdontomerus anthonomi super. *Eurytoma tylodermatis* — 1 ♂, 1 ♀.

The number of examples is much smaller where more than two individuals are concerned and one survives.

2 unknown, 1 dipteron (survivor) — 1 example.
2 unknown, 1 ♀ *Eurytoma tylodermatis* (survivor) — 1 example.
3 *Eurytoma tylodermatis*, 1 ♀ *Microdontomerus anthonomi* (survivor) — 1 example.
3 *Eurytoma tylodermatis* (1 ♀ survives), 2 *Catolaccus hunteri* — 1 example.
6 unknown, 1 ♀ *Catolaccus hunteri* (survivor) — 1 example.
7 *Catolaccus hunteri*, 1 *Microdontomerus anthonomi* (survivor) — 1 example.
16 unknown, 1 *Microdontomerus anthonomi* (survivor) — 1 example.

In the majority of cases studied all superparasites died. These records are here grouped according to the number of individuals concerned.

1. (Only two parasites involved.)

2 unknown — 75 examples.
Unknown and *Bracon mellitor* — 9 examples.
Unknown and *Catolaccus hunteri* — 2 examples.
Unknown and *Catolaccus incertus* — 1 example.
Unknown and *Cerambycobius cyaniceps* — 1 example.
Unknown and *Eurytoma tylodermatis* — 1 example.
Catolaccus hunteri and *Cerambycobius cyaniceps* — 1 example.
Catolaccus hunteri and *Eurytoma tylodermatis* — 2 examples.
Catolaccus incertus and *Eurytoma tylodermatis* — 1 example.
Cerambycobius cushmani super. *Bracon mellitor* — 3 examples.
Cerambycobius cyaniceps super. *Bracon mellitor* — 1 example.
Cerambycobius cyaniceps and *Eurytoma tylodermatis* — 1 example.
Eurytoma tylodermatis super. *Bracon mellitor* — 1 example.
Eurytoma tylodermatis and *Microdontomerus anthonomi* — 3 examples.

2. (Three parasites involved.)

3 unknown — 19 examples.
1 unknown, 1 *Catolaccus*, 1 *Eurytoma* — 1 example.
1 *Bracon mellitor*, 2 *Eurytoma tylodermatis* — 1 example.
1 *Catolaccus hunteri*, 2 *Eurytoma tylodermatis* — 1 example.
2 *Catolaccus incertus*, 1 *Eurytoma tylodermatis* — 1 example.

3. (More than three parasites involved.)

4 unknown — 5 examples.
1 unknown, 3 *Catolaccus hunteri* — 2 examples.
2 *Catolaccus hunteri*, 2 *Eurytoma tylodermatis* — 1 example.
5 unknown — 4 examples.
4 *Catolaccus incertus*, 1 *Eurytoma tylodermatis* — 1 example.
2 *Cerambycobius cyaniceps*, 3 *Microdontomerus anthonomi* — 1 example.
2 *Eurytoma tylodermatis*, 3 *Microdontomerus anthonomi* — 1 example.
6 unknown — 1 example.
2 *Catolaccus hunteri*, 4 *Microdontomerus anthonomi* — 1 example.
3 *Catolaccus hunteri*, 2 *Eurytoma tylodermatis*, 1 *Microdontomerus anthonomi* — 1 example.
4 *Catolaccus incertus*, 2 *Eurytoma tylodermatis* — 1 example.
7 unknown — 1 example.
6 *Catolaccus hunteri*, 1 *Eurytoma tylodermatis* — 1 example.
4 *Catolaccus incertus*, 3 *Eurytoma tylodermatis* — 1 example.
8 unknown — 1 example.
3 *Catolaccus hunteri*, 3 *Eurytoma tylodermatis*, 2 *Microdontomerus anthonomi* — 1 example.
9 unknown — 1 example.
11 *Microdontomerus anthonomi*, 1 *Cerambycobius cyaniceps* 1 example.
13 *Microdontomerus anthonomi*, 1 *Eurytoma tylodermatis* — 1 example.
16 unknown — 2 examples.
20 unknown — 1 example.
25 unknown — 1 example.

COMBINED SIMPLE ECTO- AND ENDOPARASITISM: It was frequently found that boll weevils internally parasitized by *Tetrastichus hunteri* Crawford were externally parasitized by one or more other parasites; such cases are usually fatal for both.

Tetrastichus hunteri lives, unknown external dies — 2 examples.
Tetrastichus hunteri dies, *Catolaccus hunteri* lives — 1 example.
Tetrastichus hunteri dies, unknown external dies — 5 examples.
Tetrastichus hunteri dies, *Cerambycobius cyaniceps* dies — 1 example.

Tetrastichus hunteri dies, *Cerambycobius cyaniceps* and unknown external both die — 1 example.
Tetrastichus hunteri dies, 3 unknown external die — 1 example.
Tetrastichus hunteri dies, 2 *Catolaccus hunteri* and 4 unknown external, all die — 1 example.

Predation upon Parasites

As was remarked on a preceding page predation frequently complicates parasitism and renders it of no avail. Of course many kinds of predation are accidental but the following examples will illustrate some phases which greatly resemble superparasitism because the attack is by larvæ:

Unknown Coleopteron super. *Bracon mellitor* — 1 example.
Unknown Coleopteron super. *Catolaccus hunteri* — 1 example.
Unknown Coleopteron super. *Eurytoma tylodermatis* — 1 example.
Catorama sp. super. *Bracon mellitor* — 1 example.
Catorama sp. super. *Cerambycobius cushmani* — 1 example.
Hydnocera pubescens super. unknown — 1 example.
Hydnocera pubescens super. *Bracon mellitor* — 11 examples.
Hyndocera pubescens super. *Catolaccus incertus* — 2 examples.
Hydnocera pubescens super. *Cerambycobius cyaniceps* — 1 example.
Hydnocera pubescens super. *Eurytoma tylodermatis* — 1 example.
Catorama sp. super. *Cerambycobius cushmani* super. *Bracon mellitor* — 1 example.
Unknown predator super. ♀ *Cerambycobius cyaniceps* super. *Bracon mellitor* — 1 example.

In the following examples the predation is by adults and is less apparently similar to superparasitism although the results are identical:

Unknown predator super. *Catolaccus hunteri* — 1 example.
Unknown predator super. *Catolaccus incertus* — 1 example.
Ants super. unknown parasite — 1 example.
Ants super. *Eurytoma tylodermatis* — 1 example.
Mites super. *Bracon mellitor* — 1 example.
Cathartus cassiæ super. unknown — 2 examples.
Cathartus cassiæ super. *Bracon melitor* — 1 example.
2 *Cathartus cassiæ* super. *Catolaccus hunteri* — 1 example.
Solenopsis geminata super. *Bracon mellitor* — 1 example.

Summary: As the large number of records given herewith makes it difficult to compare the different phases described, the following summary has been compiled:

Simple ectoparasitism: normal — the vast majority of examples.

Averted simple ectoparasitism — 1 example.

Simple endoparasitism: normal — only common in certain sections.

Multiple endoparasitism: normal — very common on weed stem weevils.

True hyperparasitism: not recorded.

Non-fatal simple superparasitism involving two individuals — 8 examples.

Non-fatal multiple superparasitism involving several individuals — 1 example.

Combined simple ecto- and multiple endoparasitism (non-fatal) — 7 examples.

Cannibal superparasitism with one survivor — 4 examples.

Mixed superparasitism involving only two individuals with one survivor — 142 examples.

Mixed superparasitism involving several individuals with one survivor — 7 examples.

Combined simple ecto- and endoparasitism with one survivor — 3 examples.

Fatal cannibal superparasitism — 34 examples.

Fatal mixed superparasitism involving two individuals — 102 examples.

Fatal mixed superparasitism involving several individuals — 54 examples.

Combined simple ecto- and endoparasitism (fatal) — 9 examples.

Total non-fatal superparasitism — 16 examples.

Total superparasitism with one survivor — 156 examples.

Total fatal superparasitism — 199 examples.

Predation by larvæ upon primary parasites — 21 examples.

Predation by larvæ upon superparasites — 2 examples.

Predation by adults upon primary parasites — 10 examples.

A superficial study of the examples given would perhaps give the idea that superparasitism is a serious drawback to control by parasites. It must not be forgotten that the many thousands of examples of pure simple parasitism have been omitted from the discussion. The writer's observations upon this most interesting phenomenon are that superparasitism seldom if ever occurs until the percentage of parasitism has become comparatively high. From the point where superparasitism does begin, however, it very rapidly acts as a check upon parasite increase until it almost completely stops the control at 75 per cent. Owing to the many other elements of weevil control it is seldom possible for parasitism to reach much above 45 or 50 per cent *of the total number of weevils in the field.* The other factors may be counted upon to average about 50 per cent of the total. With very favorable conditions the parasites sometimes reach as many as 75 per cent of the weevils.

ON THE LIFE HISTORY OF THE ALFALFA LEAF-WEEVIL

By E. G. Titus, *Logan, Utah*

The alfalfa leaf-weevil (*Phytonomus murinus* Fab.) now occurs in at least eight counties in Utah.

In 1908 the distribution was probably limited to 100 square miles in Salt Lake and Summit counties. It now covers an area eighty miles long, north and south, by seventy-five miles east and west or a gain in 1909 and 1910 equal to sixty times the previously infested area.

The present *known* infested area covers all of Salt Lake and Davis counties, north half of Utah county, southern part of Weber, northeastern Tooele, northwestern Wasatch, eastern Summit and the south half of Morgan county.

Specimens have been taken from trains passing thru Box Elder and Cache counties, these two counties forming part of the north boundary of the state. It is not unlikely that there are isolated colonies breeding in these and other counties. In Summit county it has nearly or quite reached the Wyoming line.

There are so many means of distribution, such as the spring and summer flights, railroad and wagon road transportation, carriage in fruit packages, household goods and other packages, that it is certainly a question of but a short time before the species will be present in other states.

Food Plants

It has been found feeding and breeding on seven species representing three genera of plants: alfalfa (*Medicago sativa*), burr-clover (*M. lupulina*), white sweet clover (*Melilotus alba*), yellow sweet clover (*M. officinalis*), red clover (*Trifolium pratense*), white clover (*T. repens*), alsike clover (*T. hybridum*) and crimson clover (*T. incarnatum*).

Several species of clovers have been described from the Rocky Mountain region but these seem to be rather rare and so far the weevil has not been found attacking them.

The wild sweet pea (*Lathyrus venosus*) is not uncommon thruout the state, but even where growing beside infested alfalfa plants it has not been attacked.

Failure has resulted from attempts to breed the weevils in captivity on hairy vetch (*Vicia villosa*) and buffalo pea (*Astragalus utahensis*). Adults are often found hibernating beneath the leaves of this latter plant and in captivity would occasionally eat small pieces from the leaves.

The species certainly prefers alfalfa to any other food plant so far recognized. Its next choice appears to be burr-clover (also a Medicago), closely followed by white sweet clover. Its presence on other clovers is rather rare, and it is unusual to find burr- or white sweet-clover infested early in the year.

Broods

There is evidently but one brood of the insect, but as the season advances it becomes more and more difficult to distinguish between specimens of over-wintering weevils and weevils that issued durir the season. The length of life of the adult cannot be definitely stated even in months. We have kept adults from the time they issued in May until a year from the following November, though it is probable that this is an unusually long period for them to live.

Copulation has been noticed of newly-issued males with females of the previous year in early July; and very soon afterward between specimens of the year, while mating of the over-wintering specimens appear to continue from spring to fall. The males have the same habit as those of *P. punctatus*, reported by Dr. Folsom[1] in that they follow the females around and mate a number of times.

Eggs and young larvæ found late in the fall, September to November, are probably progeny of over-wintering females and not members of a second brood. It is probable that many of these larvæ perish on account of unsuitable weather conditions but I have had adults issue as late as November 28.

Hibernation

Many of the adults go into hibernation early in the fall, even as early as the first week in August. Tho many of these come out to feed at times, it has been noticed that even a passing cloud will drive them to shelter. A cold rain following a hot day seemed to be quite destructive so that it appears they are very susceptible to climatic conditions during this period. Certainly a large number of beetles die during the summer and fall of the year they are bred.

A small amount of shelter seems to suffice for winter protection. Burlap bands on apple trees are favorite places and where such bands were placed on fence-posts along an alfalfa field many weevils were collected. They do not appear to be gregarious in their hibernating habits but each seeks its own shelter under grass, bark, in hollow trees, crevices in the ground, in buildings or almost any protected spot.

[1]1909: Folsom: Ill. Agr. Exp. Sta. Bul. 134, Apr., p. 162.

Spring Feeding Habits

They appear again at the first approach of spring and begin feeding on the alfalfa, making punctures in the stalks. This is very different from the summer and fall feeding when they rasp the epidermis from the stalk and slit the leaves into ribbons.

The feeding-puncture is irregularly oval in outline and usually made by slitting and gnawing the cavity. The weevil apparently gouges out its food and will stand for some time working small pieces loose; it will then withdraw the beak, chew and swallow the food and again return to the puncture. The injury is very often severe, especially to young stalks which are so deeply cut that many wilt and break off. During the warmer part of these early spring days weevils have been noticed mating, and egg-laying certainly commences soon after they come from hibernation. The spring flight begins with the first continued warm weather.

Oviposition

The eggs are at first laid singly on the plant; in the buds, axils of the leaves, on the stalk or beneath the leaf sheath. In this latter case the ovipositor is inserted thru the sheath, the egg being placed inside in contact with the stalk and not in the tissue of the leaf as reported for *P. nigrirostris* by Wildermuth.[1] Two to three weeks after egg-laying commences the female begins ovipositing in the stalks and this form of oviposition becomes more common as the season advances.

The egg-punctures are usually clean-cut and almost circular in outline. The weevils seen making these punctures made but one cut with the beak. Standing lengthwise of the stem, head downward, the beak was inserted at an angle slightly toward the base of the stalk and given a steady pull up and in, thus making an elongated slit inside the stem, both below and above the puncture. The beak was then withdrawn and the insect either turned around or walked forward and pushed her ovipositor into the puncture. From thirty seconds to two minutes were occupied in laying the egg, the ovipositor being withdrawn after each egg-deposit.

Sometimes a puncture is filled with eggs until they project from the aperture. When the female does not fill the puncture with eggs she sometimes plugs it with a small ball of excreta or a little mass of epidermis gnawed from the stalk. Sometimes before inserting the beak to make the puncture she first gnaws away the epidermis.

Egg-punctures in a slender stalk may cause the leaves to wilt and the stalk to die and the same thing occurs when too many egg-punctures are made in a larger stalk.

[1]1909: Webster: U. S. D. A. Bur. Ent. Bul. 85, pt. 1, p. 9.

The following tables furnish data relating to feeding-punctures, egg-punctures and eggs found in each stalk in single clumps of alfalfa at different dates in 1909 and 1910. It is believed they were fairly typical of the conditions occurring at those dates.

TABLE 1

14 March, 1910—16 stalks in one clump

No. of stalk	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Totals
Feeding-punctures	2	4	3	0	4	2	4	2	4	3	4	0	5	3	2	2	44
Egg-punctures	1	0	0	2	0	1	0	1	0	1	0	1	0	1	0	1	9
Eggs found in each	8	...	...	4	...	7	...	7	....	10	....	9	....	5	0	8	......
puncture	...	...	...	2	...	...	...	...	....	....	....	....	....	....	....	....	......
Total eggs to stalk	8	0	0	6	0	7	0	7	0	10	0	9	0	5	0	8	60

TABLE 2

9 Apr. 1909—18 stalks in one clump

No. of stalk	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals
Feeding-punctures	2	3	1	0	0	5	4	4	3	3	2	3	6	4	5	3	0	2	50
Egg-punctures	1	1	1	0	0	0	3	0	2	2	1	0	0	0	1	0	0	0	12
Eggs found in each	7	8	4	...	...	...	5	...	11	9	6	...	...	...	8	...	...	...	......
puncture	...	...	...	...	...	...	9	...	2	5	...	...	...	...	...	...	...	...	......
....	...	...	...	...	...	...	4	...	...	..	...	...	...	...	...	...	...	...	......
Total eggs to stalk	7	8	4	0	0	0	18	0	13	14	6	0	0	0	8	0	0	0	78

TABLE 3

3 Apr. 1910—16 stalks in one clump

No. of stalk	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Totals
Feeding-punctures	3	0	4	3	3	2	5	0	0	5	6	2	4	4	3	3	47
Egg-punctures	1	1	0	3	2	2	3	0	2	0	3	4	0	3	2	4	30
Eggs found in each	1	2	...	7	10	6	5	....	7	....	7	3	....	4	6	2	......
puncture	..	...	...	6	1	4	4	....	4	....	4	5	....	2	7	2	......
....	..	...	...	4	...	...	2	....	....	....	3	7	....	4	....	3	......
....	..	...	...	...	...	...	...	....	....	....	....	3	....	....	....	1	......
Total eggs to stalk	1	2	0	17	11	10	11	0	11	0	14	18	0	10	13	8	126

TABLE 4

18 April 1910—32 stalks in one clump

No. of stalk	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	Totals
Feeding punctures	1	2	1	4	1	2	1	3	1	0	2	1	0	0	0	1	0	4	0	2	0	2	0	2	5	0	3	0	2	0	0	0	40
Egg-punctures	8	18	6	0	4	0	4	0	8	0	4	0	3	0	1	6	2	9	12	11	0	4	6	3	6	8	7	0	0	2	0	0	132
Eggs found in each puncture	4	8	1	..	11	..	22	..	7	..	7	..	11	..	18	2	10	8	6	12	..	11	2	1	4	1	8	..	..	11	..	..	....
	18	2	1	..	13	..	3	..	11	..	8	..	2	..	..	6	5	14	15	3	..	12	11	6	3	6	2	..	..	9	..	..	....
	6	9	8	..	8	..	5	..	14	..	4	..	6	..	..	7	..	7	12	7	..	14	3	4	14	8	9	..	..	..	..	..	....
	4	14	11	..	4	..	6	..	9	..	9	..	..	..	..	6	..	11	8	4	..	8	8	..	11	10	6	..	..	..	..	..	....
	1	5	5	..	..	..	..	..	8	..	..	..	..	..	..	8	..	10	4	8	..	..	5	..	2	11	5	..	..	..	..	..	....
	12	2	9	..	..	..	..	..	6	..	..	..	..	..	..	4	..	17	7	9	..	..	4	..	9	7	4	..	..	..	..	..	....
	5	2	..	..	..	..	..	..	4	..	..	..	..	..	..	..	..	6	15	2	..	..	..	..	..	4	14	..	..	..	..	..	....
	6	6	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	9	11	..	..	..	..	..	..	12	..	..	..	..	..	..	....
	..	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	5	1	..	..	..	..	..	..	..	..	..	..	..	..	....
	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	9	9	..	..	..	..	..	..	..	..	..	..	..	..	....
	..	12	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	....
	..	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....
	..	7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....
	..	6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....
	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....
	..	6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....
	..	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....
	..	11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....
Total eggs to stalk	56	114	35	0	36	0	36	0	62	0	28	0	19	0	18	33	15	84	95	55	0	45	33	11	43	59	48	0	0	20	0	0	945

TABLE 5

2 May 1909—26 stalks in one clump

No. of stalk	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Totals
Feeding-punctures	4	2	5	3	0	2	1	5	1	1	6	0	3	3	2	4	2	2	3	1	2	3	6	5	4	1	80
Egg-punches	2	8	0	4	5	4	0	3	1	3	7	4	3	6	3	2	5	1	1	0	8	4	2	3	0	5	84
Eggs found in each	3	14	..	8	12	1	..	9	12	8	11	4	7	8	1	9	8	4	5	..	4	2	6	4	..	9	...
puncture	13	9	..	3	4	5	..	8	..	4	6	7	8	4	3	8	3	..	..	..	6	3	1	7	..	8	...
	..	3	..	3	2	4	..	10	..	3	10	4	6	2	9	..	12	..	..	..	5	5	..	6	..	13	...
	..	7	..	1	3	6	..	..	..	..	8	5	..	6	..	..	4	..	..	..	3	11	..	..	..	4	...
	..	2	..	..	3	..	..	..	..	..	4	..	..	9	..	..	5	..	..	..	8	..	..	..	..	7	...
	..	3	..	..	..	..	..	..	..	..	5	..	..	4	..	..	..	..	..	..	1	..	..	..	..	..	...
	..	4	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	4	..	..	..	..	..	...
	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	9	..	..	..	..	..	...
Total eggs to stalk	16	43	0	15	24	16	0	27	12	15	46	20	21	33	13	17	32	4	5	0	40	21	7	17	0	11	484

TABLE 6

25 May 1909—14 stalks in one clump

No. of stalk	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Totals
Feeding-punctures	3	1	5	2	1	0	1	0	3	0	3	1	2	1	23
Egg-punctures	6	1	3	2	0	0	4	5	0	0	9	4	3	1	38
Eggs found in each	5	9	3	5	....	....	6	5	....	....	7	7	5	26	......
puncture	4	....	4	11	....	....	4	3	....	....	6	11	6	....	......
	9	....	3	....	....	....	10	4	....	....	11	2	4	....	......
	16	....	....	....	....	....	2	5	....	....	2	3	....	....	......
	2	....	....	....	....	....	....	1	....	....	4	....	....	....	......
	4	....	....	....	....	....	....	....	....	....	1	....	....	....	......
	....	....	....	....	....	....	....	....	....	....	5	....	....	....	......
	....	....	....	....	....	....	....	....	....	....	6	....	....	....	......
	....	....	....	....	....	....	....	....	....	....	8	....	....	....	......
Total eggs to stalk	40	9	10	16	0	0	22	18	0	0	50	23	15	26	229

TABLE 7

21 May 1910—9 stalks in one clump

No. of stalk	1	2	3	4	5	6	7	8	9	Totals
Feeding-punctures	4	1	5	6	4	1	0	3	2	26
Egg-punctures	2	3	2	7	4	4	6	8	8	44
Eggs found in each puncture	11	8	1	8	5	1	9	14	16	....
....	9	16	1	6	2	3	11	15	4	....
....	....	4	....	14	11	9	8	3	3	....
....	....	....	....	3	10	6	7	2	11	....
....	....	....	....	17	....	....	10	1	9	....
....	....	....	....	9	....	....	1	1	2	....
....	....	....	....	8	....	....	....	6	5	....
....	....	....	....	....	....	....	....	8	8	....
Total eggs to stalk	20	28	2	65	28	19	46	50	58	316

TABLE 8

18 June 1910—21 stalks in one clump

No. of stalk	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Totals
Feeding-punctures	2	0	2	2	3	0	1	1	1	0	2	1	2	1	0	1	2	2	1	1	3	28
Egg-punctures	1	2	0	3	1	0	2	0	1	2	0	2	2	2	1	0	2	1	0	1	1	24
Eggs found in each puncture	11	2	..	2	4	..	4	..	4	3	..	2	4	9	3	..	8	6	..	4	5	......
......	..	4	..	4	..	..	3	..	..	3	..	4	3	4	..	..	4	..	..	..	..	......
......	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	......
Total eggs to stalk	11	6	0	8	4	0	7	0	4	6	0	6	7	13	3	0	12	6	0	4	5	102

TABLE 9

6 July 1909—18 stalks in one clump

No. of stalk	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals
Feeding-punctures	2	0	0	0	0	0	0	1	2	2	1	1	2	0	0	0	0	1	12
Egg-punctures	1	1	1	0	2	1	1	1	1	0	1	0	1	0	0	0	0	1	16
Eggs found in each puncture	7	14	16	...	9	4	8	7	5	0	12	0	8	...	...	...	...	2	......
	...	...	...	...	11	...	...	...	...	...	...	...	...	...	...	...	...	...	......
Total eggs to stalk	7	14	16	0	20	4	8	7	5	0	12	0	8	0	0	0	0	2	93

TABLE 10

7 July 1910—20 stalks in one clump

No. of stalk	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Totals
Feeding-punctures	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	0	0	0	5
Egg-punctures	1	0	0	1	0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	0	6
Eggs in each puncture	9	0	0	3	0	0	0	8	0	0	7	0	4	0	0	2	0	0	0	0	33

The season of 1910 was three to four weeks in advance of 1909 as has been graphically shown in a recent bulletin by the author.[1] Hence tables for 9 Apr. 1909, and 14 Mch. 1910, represent practically equivalent times in the two years so far as the alfalfa-growth and life-history of the weevil are concerned.

In the same manner 2 May 1909 and 3 April 1910, 25 May 1909 and 18 April 1910, and 6 July 1909 with 18 June 1910. It will be noticed with these last two dates mentioned that the comparison with 7 July 1910 shows that the seasons were by that time more nearly equal. After early July both egg and feeding-punctures are very rare. The adults that are still laying eggs evidently deposit them singly as they did at the beginning of the season.

Early in the spring there are many more feeding-punctures than egg-punctures and it is not until the adults have been laying eggs for several weeks that they bring the number of egg-punctures up to an equality. As the season advances the adults feed more and more on the leaves and epidermis of the stalk and make less feeding-punctures, so that the final relation is nearly equal.

The maximum number of feeding-punctures to any stalk does not go far above the average, although as many as six were counted several times. Eighteen egg-punctures in one stalk, even in a large stout stalk as this one happened to be, fairly riddled the stalk and it had broken down. Twenty-six eggs hardly crowded the stalk they were in; it was large and somewhat hollow and the female could have deposited more so far as space was concerned but she instead plugged up the hole with excreta.

After a few weeks of strenuous and rapid egg-laying eggs are again laid sparingly for an indefinite period, certainly until late in October and perhaps until complete hibernation begins. Over-wintering females were examined in early November and found to still contain a number of well-developed eggs.

[1] 1910: Titus: Utah Agr. Exp. Sta. Bul. 110. Charts I and II.

TABLE 11

Final totals and averages

1909	No. of stalks in clump	Feeding-punctures	Egg-punctures	Eggs in clump	Relation of Feeding-punctures to egg-punctures	Average feeding-punctures to stalk	Average egg-punctures to stalk	Average eggs to egg-punctures	Average eggs to stalk
9 Apr.....	18	50	12	78	4.1 to 1	2.77	.66	6.50	4.30
2 May....	26	80	84	484	1 to 1.05	3.07	3.23	5.76	18.61
25 May....	14	23	38	229	1 to 1.64	1.64	2.71	6.03	16.70
6 July....	18	12	16	93	1 to 1.33	.66	.88	5.81	5.16
Totals.....	76	165	150	884	1 to 1.1	2.17	1.93	5.89	11.63
1910									
14 Mch....	16	44	9	60	4.9 to 1	2.75	.56	6.60	3.75
3 Apr.....	16	47	30	126	1.59 to 1	2.93	1.87	4.20	7.87
18 Apr.....	32	40	132	945	1 to 3.3	1.25	4.12	7.16	29.50
21 May....	9	26	44	316	1 to 1.65	2.88	4.88	7.18	35.10
18 June....	21	28	24	102	1.17 to 1	1.33	1.14	4.25	4.85
7 July....	20	5	6	33	1.2 to 1	.30	.25	5.50	1.65
Totals.....	114	190	245	1582	1.28 to 1	1.66	2.15	6.46	13.96
Totals..... 1909-10 ...	190	355	395	2466	1.11 to 1	1.81	2.07	6.24	12.98

NOTES ON STAGES

EGG: The egg is oval, rounded at the ends and when first deposited is lemon-yellow in color, 0.55 mm. to 0.65 mm. long and 0.32 mm. to 0.38 mm. wide. Two to four days after being laid, a dark spot appears at one end and as incubation progresses, this spot enlarges, the egg becoming somewhat paler on the other portions. Under the microscope the surface of the egg appears very slightly roughened and sculptured with hexagonal depressions. At one end this hexagonal sculpturing is somewhat drawn out until it appears like striæ. The incubation period varies from seven to sixteen days, having an average of about ten days.

HATCHING RECORD

Table 12 shows period of incubation for 1139 eggs taken at different periods during 1909 and 1910.

TABLE 12

Date laid	Number of eggs	Days of incubation 7	8	9	10	11	12	13	14	15	16	Failed to hatch
6 March.	5	3	2	..	..	..	..	..	..	..	..	0
8 March.	30	..	5	..	9	2	..	..	..	..	..	14
21 March.	112	..	9	6	74	8	1	1	1	..	..	12
22 March.	86	1	8	32	34	..	1	..	..	..	..	10
30 March.	27	..	..	..	2	19	4	..	..	..	..	2
9 April ..	38	..	1	..	30	5	..	..	..	..	..	2
15 April ..	7	..	..	..	..	..	..	1	4	..	..	2
16 April ..	60	..	2	11	28	..	9	..	..	..	..	10
18 April ..	140	4	7	14	76	27	8	1	..	..	..	3
19 April ..	19	..	5	5	4	3	..	..	..	..	..	2
23 April ..	246	..	..	8	86	92	8	4	8	4	4	32
25 April ..	138	..	..	15	82	22	10	..	..	..	..	9
10 May ..	56	..	..	..	20	20	..	..	..	..	..	16
20 May ..	27	..	..	14	9	..	..	..	..	..	..	4
25 May ..	33	..	7	5	..	..	..	..	..	..	..	11
31 May ..	46	..	9	9	22	2	..	..	..	..	..	4
10 June ..	50	..	..	28	20	..	..	2	..	..	..	0
15 June ..	16	..	..	9	4	..	..	..	1	..	..	2
24 June ..	13	..	..	..	..	..	..	4	1	..	..	8
	1139	8	55	156	500	200	41	13	15	4	4	143

Average hatching period = 10.22 + days.

LARVA: The larva does not cut an opening in making its exit from the shell, but by muscular contractions, rolling and twisting inside the shell, they obtain sufficient pressure to burst through the exceedingly thin membrane, which becomes brittle about hatching time.

The larva upon first hatching is 1.4 mm. to 1.5 mm. long and 0.35 mm. wide, and has the head shield dark, with only a faint trace of the inverted "Y" on the face. The remainder of the body is pale dirty yellow with the black spots on the segments showing distinctly. The hairs on the anal segments are much longer than those on the other portions of the body and are enlarged at the tips. The white median stripe on the dorsal surface is faintly indicated.

The larva when five to six days old sheds its skin and passes into the *second stage*, the head at this time becoming distinctly darker and the inverted "Y" on the face a dirty white. The white dorsal stripe

is very distinct, the remainder of the larva being green in color, somewhat lighter than that of the alfalfa on which it is feeding. The length of the larva in this stage is 3.2 mm. to 4.8 mm. by 0.7 mm. to 1.1 mm. wide.

With the *third moult* the larva becomes still darker green, the dorsal line almost pure white, an indistinct white stripe on each side of the body, and the white inverted "Y" on the face distinct. In this third stage, the length varies from 5.5 mm. to 9.2 mm. by 1.25 to 2.25 mm. wide (near the center of the body).

Cocoon: When full grown, the larvæ either crawl or drop to the ground, usually the former, spinning their cocoons in the dead leaves or other rubbish there present. When there is short dead alfalfa present, such as that injured by frost, the cocoons may be found in the dead leaves as high as six inches from the ground.

The cocoon is globular, 5 mm. to 8 mm. in diameter, and is composed of a rather coarse network of pure white threads. The larva, in spinning this cocoon, at first curls into the same posture in which it usually feeds, and begins to work a mass of threads on one side and partly beneath it; later working its way into this small network and then gradually carrying the network over from one side to the other, and working in the cross threads connecting these portions. While the larva is spinning the cocoon it often curls its anal end to the mouth apparently to secure some secretion. Cocoons are usually globular, especially those made in a curled leaf, but are often made to fit the curl of the leaf. The larvæ take from ten to twenty hours to spin a cocoon, and usually do not moult into the pupa stage for from thirty-six to seventy-two hours after the cocoon is formed.

Pupa: The newly formed pupa is pale green, the eyes somewhat darkened, the posterior end of the femora, and the anterior end of the tibiæ rather dark. The abdomen has a pale dorsal line, and bears a number of hairs at the extremity. There are a series of setæ with enlarged ends on each dorsal segment, but apparently few setæ on the ventral side. The length of the pupal stage averages about eight days.

Moulting: The larvæ in all stages seem to have the same general process of moulting. This casting off of the skin is rather a slow process. The first evidence is the slight shortening of the larva, soon followed by the splitting of the head plate, beginning at the center of the inverted "Y." This split increases in three directions along the inverted "Y," the parts rolling back and allowing the head to be protruded, the split then spreads a short distance down the back, rarely more than two segments, the larva working its way out through this opening. The cast skin soon dries and shrivels up, so that it is

almost impossible to find it. In its last stage, the larva when changing into the pupa, casts the skin in like manner.

ADULTS: The adults are oval in shape and when freshly emerged are pale brown with a distinct darker line extending centrally down the back. They harden in from one to three days depending somewhat upon the amount of sunshine present when they are developing; then cut their way out of the cocoon, usually at one end, crawl up an alfalfa stalk and begin feeding.

Late in the summer some of the hairs and scales get rubbed off, causing the weevil to appear much darker in color. Before the following spring is passed many have lost nearly all the hair and brown scales and appear black with small irregular gray spots on the elytra.

A detailed description of the adult has already been published.[1]

An examination of the type of *Phytonomus castor* Lec. shows that that species is not identical with nor even scarcely similar to *P. murinus* Fab.

CODLING MOTH CONTROL IN CALIFORNIA

By C. W. WOODWORTH

The recent Apple Show held at Watsonville, California, has not only the distinction of being the greatest exhibit in the history of apple growing, but marks a significant accomplishment in economic entomology. Watsonville is by far the greatest shipping point for apples in the world, sending out now about sixty cars per day, and the season's crop will be over 4,000 car loads. Only during the last eight years has there been any appreciable amount of spraying for codling moth. Through the efforts of the Experiment Station of the University of California the local difficulties have been overcome, and spraying may be said to have been placed on a practical basis only four years ago. Each year has seen an extension of spraying, until during the present season over sixty tons of arsenate of lead have been used in the Pajaro Valley on about 95% of the acreage in apples, all of it within ten miles of the city of Watsonville.

Spraying is almost entirely done with high pressure outfits, and there are certainly more power-spray outfits in this region than in any other fruit section. The complaint is not infrequently made in the East that growers will not carry out the suggestions of entomologists. This valley furnishes a conspicuous example of "applied" entomology. Most Western entomologists feel that their work is

[1] 1909: Titus: Journ. Ec. Ent. v. 2, p. 151.

done only when their methods become the regular practice of the growers.

The difficulties met with in the Pajaro Valley in spraying for codling moth have never been discussed except locally, and may be of interest to Eastern entomologists.

Before the investigation was taken up at Watsonville many complaints came to the Department of the burning produced by Paris green and gave occasion for the study of the greens on the market in the state, reported in Bulletin 126, in which it was shown that much of that material contained water soluble arsenic. The outcome of this study was a law defining the amount of free arsenic permissible in Paris green which was also adopted in other states and which has resulted in improving the foliage safety of Paris green all over the United States.

It was soon found that the climate about Watsonville and not the free arsenic in Paris green was the determining factor in the problem in that region.

The Pajaro Valley opens out on Monterey Bay and lies opposite the Pecheco Pass. The cold winds from the ocean blow across this valley to replace the heated air of the great San Joaquin Valley, just as the winds sweep through the Golden Gate at San Francisco towards the Sacramento Valley. In consequence there are almost daily fogs from the ocean every evening during all the summer. The continual drenching of the trees by these fogs hydrolizes almost all arsenicals, setting free the acid, and after two years of experiment involving losses of thousands of dollars in some orchards on account of arsenic injury to foliage, Paris green had to be discarded entirely.

During the third year of the investigation it was also clearly seen that none of the commercial brands of arsenate of lead could be safely used in the Valley and that and the following years hundreds of arsenicals were made up and tested and the solution of the problem finally came from the discovery that certain samples of lead arsenate, both as obtained on the market and made up in the laboratory did not injure foliage, and that these samples were distinguishable by the fact that they contained no arsenic acid soluble in ammonia, that is, they consisted of a saturated lead salt. Nearly always by the ordinary methods of manufacture an arsenate of lead consists of an acid salt or a mixture of an acid and a basic arsenate of lead.

Two of my assistants undertook to work out, as a private venture, a method of manufacture by which a uniform product of this character could be obtained. They were entirely successful and organized the California Spray Chemical Company, largely financed by local orchardists, the product of which has contributed in no small degree to the final success of the effort to control this insect.

Besides the smaller experiments many tons each of such good commercial brands of arsenate of lead as Swift's, Lavenburg's and Sherwin-Williams' have been tried in the Valley and in each case with disastrous results.

Not only does the control of the codling moth require a special kind of lead arsenate, but the spraying program presents striking peculiarities.

At this time when such good results are reported as coming from a return to the old idea of a single thorough blossom-cup spraying, and some entomologists are contending that all later sprayings should be eliminated, it may come as a surprise to some that the Watsonville spraying program, which, in the hands of our best orchardists gives as good results as are obtained anywhere, absolutely ignores the blossom-cup work.

A small portion of the valley is naturally immune. The portion between Watsonville and the sea is affected so early by the cold ocean winds that the moth rarely flies. At Watsonville often for a month at a time no insects of any kind are seen about electric lights. These cold winds make the Pajaro Valley produce winter apples along the seashore side by side with oranges, grape-fruit and lemons. While in most of the valley the codling moth flies often enough to lay its full quota of eggs, still its life history and the growth of the tree are profoundly modified. Thus the blossoming period extends over such a long period that the first fruit set usually are advanced so far as to render the poisoning of the cup impossible before half of the buds are open. At least three sprayings would be necessary if one wanted to fill all the blossom cups. Likewise the moth is very irregular in appearing in the spring, the emergence of overwintering individuals requiring three months from the first to the last,—more than enough time for a full generation of the more precocious to develop.

The delayed appearance of the moths in the spring results in the great majority of individuals attacking the fruit after it is already well advanced, and a very small per cent of the entrances are in the blossom cup. No real blossom-cup spraying has ever been done in the Pajaro Valley except in our experiments and they showed no results sufficient to justify the recommendation of the method.

The spraying program usually begins with an application about the time the last blossoms appear. This is usually long after the calyx lobes of all the fruit that will set have closed. This spray may be followed by one or two applications at intervals of a month or six weeks, the number varying with the season and the portion of the valley.

These sprayings simply reduce the number of worms that may attack the crop later. The first generation of worms are not con-

sidered as having any direct effect on the crop since the infested apples either drop or are removed at thinning.

Many of our orchardists make no further sprayings, but almost always to their loss. The best orchardists begin a campaign of one to three sprayings, beginning about the middle of August. There will undoubtedly be an improvement in this matter during the next year or two. Probably the amount of poison used in this section will ultimately be over a hundred tons.

Over 1,600 barrels of commercial lime-sulfur solution were used during the past winter for San José scale, and this material is now being produced in the local factory with a density of 36 degrees Beaumé, which is considerably stronger than anything in the market in the East.

There is very little scab and scarcely any use of Bordeaux mixture; there is beginning to be a little iron sulphid used with the lead for mildew and occasionally zinc arsenate replaces the lead for the first spraying where the tussock moth must be dealt with.

The minimum sprayings that give good results in any part of the Valley are three, two for the first brood and one in August, and the maximum is six, three for the spring and three in the summer, and except for the early spring applications must be a strictly neutral arsenate of lead, one containing no ammonia soluble arsenic.

The Common Name of the Black Scale (*Saissetia oleæ* Bern).—In Vol. II, No. 6, of this JOURNAL Mr. J. G. Sanders gives the common name of *Saissetia oleæ* Bern. as the "Olive Scale." He says, "the popular name 'Black Scale' has been applied to this species, but rather incorrectly, since it is usually very dark brown; the above name should be applied properly to *Saissetia nigra*, which in the adult female stage usually becomes truly black."

This brings up the question of the real usefulness of common names for insects. It is true that from its specific name "*oleæ*" and also its avidity to attack the olive it should be called the "Olive Scale." But since the name "Black" has become so well established, and, moreover, has been the name officially adopted by the Association of Economic Entomologists, it hardly seems wise to change it at this late date. Common names are useful chiefly to growers and others who are not entomologists. Entomologists in most cases are as familiar with the scientific name as the common name, and there is much less chance for confusion regardless of how appropriate a common name may be.

Saissetia oleæ as an economic insect in the United States is most important in California, and particularly in the southern California citrus belt. Here every grower of citrus trees knows it as the Black Scale and it would lead to needless confusion to attempt to call it anything else. On the other hand, *Saissetia nigra* Nietn. is not an economic pest anywhere in the United States, and it is of little consequence whether it has any common name at all. From the specific name "*nigra*" it could of course be appropriately called the Black Scale. But since common names are largely applied to insects of economic importance it would be likely to lead only to confusion to include the entire list of insects. While the Black Scale may not always be black, it is blacker than any others of economic importance associated with it, and to change so well established a name on a mere shade of color hardly seems justifiable.

H. J. QUAYLE.

RECENT EXPERIMENTS WITH THE CODLING MOTH

By E. P. Felt, *Albany, N. Y.*

Last year we summarized the work against this pest and were able to present records showing 98.55 to 98.81% of worm-free fruit as a result of one spraying, while check trees yielded 72.73% of sound apples. The same care was exercised in selecting the trees in 1910 as the preceding year (see Journal Economic Entomology, 2: 172–73) and in the case of series 1 the experimental trees were in the same orchard, though it was necessary to spray Northern Spy trees instead of Baldwins. Series 2 was limited to Baldwins, while small Wealthy and Mackintosh trees were used in series 3. Practically without exception arsenate of lead (15% arsenic oxide) was used at the rate of about 6 lbs. to 150 gallons of spray. One gallon of a concentrated lime-sulfur wash (about 30° Beaumé) was used as a fungicide in series 1, while in series 2 the normal Bordeaux mixture was employed for this purpose. Plot 1 in both series 1 and 2 was sprayed once just after the blossoms fell, while plot 2 in each of these series received an additional application about three weeks later, namely in early June. Plot 3 in series 2 was sprayed only once and that in early June at the time of the second spraying in plot 2. The treatment of the trees in series 3 was practically identical with the spraying described above for plot 1 in series 1 and 2.

The season of 1910 was remarkable for the development of a large second brood and consequent prevalence of wormy apples. In some unsprayed orchards over 50% of the fruit was thus affected. May

SUMMARY OF PLOTS

Series	Plot	Total	Clean Fruit		Wormy Fruit						
			Total	Per cent	Total	Per cent	End Wormy	End and Side Wormy	Side Wormy	Exit Hole 1	Exit Hole 2
1	1	1,839	1,664	90.48	175	9.52	16	21	138	83	3
	2	2,846	2,756	96.84	90	3.16	6	1	83	33	0
2	1	8,135	6,677	82.08	1,458	17.92	160	27	1,271	485	3
	2	7,316	6,105	83.45	1,211	16.55	127	10	1,074	581	5
	3	7,594	4,355	57.35	3,239	42.65	1,485	326	1,428	882	33
3	Wealthy	529	371	70.14	158	29.86	12	0	146	23	..
	Mackintosh	444	219	49.33	225	50.67	25	4	106	44	..
1	Checks	711	202	28.41	509	71.59	186	240	82	298	40
2	Checks	2,000	593	29.65	1,407	70.35	700	324	383	372	20
3	Wealthy Checks	88	36	43.19	50	56.81	20	13	19	2	..
3	Mackintosh Checks	390	130	33.34	260	66.66	84	38	138	53	4

30 there was a hail storm (which did not affect series 1 and 2) and an examination showed that from 50 to 60% of the wormy fruit had been entered at points injured by the hail.

The above tabulation gives a summary which at first sight, at least, compares very unfavorably with the figures obtained in 1909. It will be seen at once that the percentage of clean fruit on sprayed trees varies from 96.84 down to 57.35 or even to 49.33, while the percentages of sound fruit on the check trees in the various plots range from 43.19 to 28.41. These last figures show at once that the codling moth was much more abundant in the Hudson valley the past season than in 1909.

Plots 1 and 2 in series 1 and 2 are respectively nearly comparable, since it will be seen by reference to the table that the percentage of infested fruit on the check trees was nearly the same. Nevertheless, there is a marked decrease in the percentage of sound fruit obtained in series 2, plot 1 yielding over 8% less than plot 1 in series 1, while plot 2 produced some 13% less of sound fruit, this in spite of the fact that the trees in series 2 bore a much larger crop and should normally produce a relatively larger percentage of sound fruit (see Journal Economic Entomology, 3:175). This discrepancy may be explainable in part by the fact that the orchard in series 1 was younger and somewhat cleaner than that in series 2, though it would seem as if a portion of this difference must be attributed to less efficient spraying in series 2, especially as experience has shown that apparently minor inattention to the application may result in a material reduction in the amount of sound fruit. Furthermore, the trees in the orchard of series 2 were somewhat closer together. There was a moderately steep hillside making thorough work somewhat difficult near the experimental trees. The majority of the other trees in the orchard were sprayed but once with Paris green and Bordeaux mixture. This application would, in our judgment, hardly be as effective in controlling the second brood of codling moth as the more adhesive arsenate of lead.

A study of the individual trees yields some data of interest. In series 1, plot 1, the number of apples per tree varied from 114 to 627. The percentage of sound fruit ranged from 85.38 to 92.98, while the number of wormy apples produced per tree was 9 to 44 or an average of a little over 29 per tree. It is worthy of note that 8.6% of the total fruit in this plot was side wormy, 7.5% being side wormy only. In plot 2 the number of apples per tree varied from 229 to 980, the percentage of sound fruit ranging from 93.93 to 97.81 and the number of wormy apples from 5 to 28, an average of only 15 per tree. There was only a little over 3.3% of the apples in this plot that were either

side and end and side wormy, or, in other words, there was a reduction in the number of side or end and side wormy of nearly 6.3% from that in plot 1, resulting in the almost total elimination of end wormy fruit.

Comparisons with similar plots in series 2 show that the yield per tree in plot 1 ranged from 884 to 1,928, the percentage of sound fruit varying from 77.96 to 85.52, while the number of wormy apples ran from 163 to 365, or an average of 243 wormy apples per tree. Fifteen and nine-tenths per cent of the total were side wormy or end and side wormy, the latter being practically a negligible quantity. In plot 2 the yield per tree was from 134 to 2,258. The percentage of sound fruit ranged from 79.09 to 86.94, while the number of wormy apples varied from 28 to 302, or an average of nearly 202 per tree. Fourteen and eight-tenths per cent were side wormy or end and side wormy. It will be seen at once that these two series present a marked contrast to each other.

The data obtained from plot 3 of series 2 are of interest largely because they give a definite basis for estimating the value of delayed spraying or one spraying given at the time the codling moth larvæ are entering the apples, namely about three weeks after the dropping of the blossoms. The number of apples per tree in this plot varied from 315 to 1,708. The percentage of sound fruit ranged from 36.19 to 78.39, while the number of wormy fruit per tree ran from 201 to 811, an average of nearly 540 per tree, or practically twice as many as were found on either plots 1 or 2. Taking the check trees as a standard, this one application reduced the wormy apples by 27.70%, which should be compared with the reduction made by one early application, namely 52.43%. Using either the actual number of wormy apples or the percentage, it will be seen that this late spraying was only about one half as effective as one earlier.

The results in series 3 emphasize the difficulty of securing even a moderate percentage of sound fruit when there is a very small crop. Furthermore, we find a markedly higher percentage of wormy apples on the Mackintosh trees, though the Wealthy were interspersed.

We alluded earlier to the very satisfactory percentages of sound fruit obtained last year, yet the individual trees on two plots sprayed but once produced from 41 to 111 and 36 to 80 wormy fruit respectively, an average for each of 60 and 50, whereas plots 1 and 2 in series 1 of 1910, while producing a markedly smaller percentage of sound fruit, bore from 9 to 44 and 5 to 28 wormy apples, an average for these plots respectively, of 29 and 15 per tree. Percentage comparisons, while in the main accurate, by no means tell the whole story. For example, in plot 1, series 1, one tree produced 9 wormy fruit,

nearly 8% of the total yield of 114, while two other trees yielded 44 wormy apples which comprised 9.93 and 7.02% of their total product. Here we have an instance of one tree producing one fifth as many wormy apples yet bearing a higher percentage of wormy fruit, while two others in this plot, each with 44 wormy apples, gave a percentage variation of 2.91. Again, in plot 2 of series 2 the maximum number of wormy apples, namely 295 amounted to but 13.06% of the total yield of the tree, while the smallest number of wormy apples, namely 28, constituted 20.91% of the product of another. In other words, the tree with 10 times as many wormy apples produced a markedly smaller percentage of wormy fruit. Likewise, the very low percentages of sound fruit obtained in series 3 is due not so much to the large number of wormy apples as to the small crop. The Wealthy trees, for example, had but 5 to 48 wormy apples, an average of only a little over 26 per tree, while in the case of the Mackintosh the wormy fruit ranged from 8 to 69, an average of a little over 37 per tree. Comparing these figures with the wormy fruit produced by the two plots sprayed but once in 1909, we shall see that there were only half as many wormy apples, yet the percentages of sound fruit for these two plots are extremely low. We call attention to this matter simply to emphasize the fact that percentage comparisons alone are not always fair. The actual number of wormy apples on the trees in series 1 and series 3 are less than those obtained in 1909, and while we wish the percentages were better, we feel that the discrepancy between the results obtained in the two seasons is not so wide as would at first appear.

NOTE ON THE OVIPOSITION OF THE TARNISHED PLANT BUG

By F. H. Chittenden and H. O. Marsh

In 1884 Dr. S. A. Forbes wrote an exhaustive account of the tarnished plant-bug, four stages of the nymphs being recognized, described in detail, and figured, but at that time nothing was published in regard to the egg or the method of its deposition. The following year this account was supplemented by a description of the egg, drawn from a specimen found on the petiole of a dead strawberry leaf and loosely placed among the hairs. Identification was made by comparison with others obtained from the female by dissection. In Woodworth's article, which appeared in 1889, the egg is also described

and figured in outline. Of this he wrote: "We have spent considerable time in fruitless search this spring. We have repeatedly dissected them from the adult insect and represent one so obtained in figure 1." Evidently only Forbes and Woodworth have hitherto written of the eggs, and neither described the method of oviposition. The extreme difficulty of keeping the insect alive in confinement makes it no easy task. These remarks aptly sum up the difficulties of investigating the life history of so small and active an insect.

The egg was first found April 19, having been deposited by a female on kale, and slightly inserted on the upperside of the leaf. The same day several adults of both sexes were found among the leaves of mullein, which is obviously a favorite spring food plant, since their abundance on this weed has also been recorded by Forbes. From one to half a dozen bugs were found on every plant examined, resting among the leaves. None appeared to be feeding or mating while under observation. In confinement they fed on kale and mullein, but it was not until April 26 that eggs were again obtained, nine in all.

May 23 the insects were observed in the field on mullein and volunteer turnip (*Brassica campestris*), and eggs were found in the seed-stalks, stems, and leaves of the latter, scattered about singly and in irregular rows or groups, sometimes three being placed close together.

The eggs, as was surmised by Woodworth, are inserted by means of the ovipositor and thrust straight into the stems toward the center. When deposited on leaves they are usually inserted in the midribs, but occasionally also on the edges of the leaves. Many have been observed deposited in this way in confinement. Evidently in nature they are deposited chiefly in the stems, less seldom in the midribs, and only occasionally in the leaves. When deposited in the stems the eggs are inserted until flush with the surface, while those deposited in leaves are usually thrust only partially into the tissue of the leaf.

In case of oviposition on mullein, which is the favorite plant for the purpose in the District of Columbia, the eggs are inserted in the petiole or leaf-stem and in the midrib. They are frequently placed very closely together and in confinement as many as nine were counted on a single leaf an inch long and half as wide.

A comparison of the stages figured and described by Forbes with material obtained at Washington leads to the conclusion that the second stage was missed; indeed, it is probably this stage that has been more often overlooked than any other by those who have written of the life stages of the Heteroptera. In Woodworth's account the first and second stages are correctly figured, and his third stage is in reality the fourth. In Stedman's article, what he terms a second stage is either the third or fourth, while his fourth stage represents

the fifth. Only four stages of growth between the egg and the mature form have hitherto been recognized. Dr. L. O. Howard stated in 1901,[a] "The natural egg place of this common insect is not known, but the rest of its life has been well worked out by Woodworth, although there is probably one more molt than he has observed, *i. e.*, five instead of four." The senior writer has also said of this species, "There is little doubt that there are five stages, to agree with other species of plant-bugs which have been traced through their metamorphoses," this deduction having been drawn from his experience in rearing Anasa and Leptoglossus and that of Quaintance and Slingerland, who have observed five nymphal stages of *Pamera vincta* Say and *Pœcilocapsus lineatus* Fab., respectively.

THE EFFECT OF MOISTURE AND DRYNESS ON THE EMERGENCE FROM THE EGG OF THE WALKING-STICK, *DIAPHEROMERA FEMORATA* SAY

Henry H. P. Severin, Ph. D., *Professor of Zoölogy and Entomology, College of Hawaii* and Harry C. Severin, M. A., *Professor of Entomology, South Dakota State College of Agriculture and Mechanic Arts*

Heymons[1], Godelmann[2] and Stokard[3] have all noticed that in various species of Phasmidæ some specimens, after issuing from the egg, may have one or more legs caught within the egg-shell and drag it after them for hours. Besides confirming these observations we frequently noticed that one or both antennæ or even the abdomen together with one or more legs may fail to be withdrawn from the egg-capsule. Some specimens, after having withdrawn the prothorax, part of the head and mesothorax, were unable to extricate themselves further.

A number of experiments were performed in order to determine why the walking-sticks fail to emerge completely from the egg-shell. One thousand eggs were kept on wet sand in a breeding cage; another thousand were put in a tin box and kept perfectly dry from the time they were deposited in the autumn. The following table shows the results of hatchings of two hundred eggs kept in dry and moist surroundings.

The table shows that 13% of the 200 specimens hatched under wet conditions, and 94% of the 200 specimens hatched under dry con-

[a]The Insect Book, New York, 1901, p. 301.

TABLE 1

	Wet conditions	Dry conditions
Number of eggs hatched	200	200
Specimens which emerged completely from the egg-shell	174	12
Specimens unable to emerge completely from the egg-shell	26	188

ditions failed, after springing off the operculum, to extract themselves completely from the egg-shell. It is evident from this that dryness has a marked effect upon the complete emergence of the walking-stick from the egg.

In the next experiment, some of those specimens, which failed to free themselves fully from the egg, were put into a glass jar containing about an inch of wet sand covered with moistened filter paper. Those walking-sticks, which had one or more legs caught within the egg-shell, usually succeeded in withdrawing all the appendages, while those that had all the legs, antennæ and abdomen caught, ordinarily failed to free themselves.

In another experiment, some of the walking-sticks, which failed to extricate themselves completely from the egg, were put into a glass jar under dry conditions. These specimens, without exception, failed to withdraw the parts caught within the egg-capsule and all died with the same parts still held securely within the egg.

Godelmann[1] observed in *Bacillus rossi*——? that "die jungen Larven die Eihülsen auf die Dornen der Brombeerranken zu stulpen versuchten und dann mit den Vorderfüszen klimmzuartige Bewegungen ausführten, um sich zu befreien, wobei nicht selten ein Bein oder mehrere verloren gingen, die dann später nach der Häutung regenerirt wurden." In only a few cases, have we observed a walking-stick throw off a leg which was caught within the shell-egg. When a specimen, which had one or more legs caught, was put in a glass jar containing a twig from a hazel-nut shrub, the leaves furnished enough moisture by transpiration to allow nearly all of the young walking-sticks to withdraw the appendages.

The eggs, which still remained unhatched, were now interchanged, the remaining 800 eggs, which had been on the wet sand being transferred to the dry conditions and *vice versa*. The following table shows the results of the hatching of the next 100 eggs in each case:

TABLE 2

	Transferred from wet to dry conditions	Transferred from dry to wet conditions
Number of eggs hatched	100	100
Specimens which had emerged completely from the egg-shell	8	80
Specimens unable to emerge completely from the egg-shell	92	20

The table shows that 92% of the 100 specimens which hatched from the eggs that were kept formerly under wet conditions and then transferred to dry, and 20% of the 100 specimens which hatched from the eggs that were formerly kept under dry conditions, and then transferred to wet, failed, after pushing off the operculum, to extricate themselves completely from the egg-capsule. It is evident from these experiments that dryness at the time of hatching has a marked effect upon the emergence of the walking-stick from the egg.

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[2] **Heymons, R.,** 1897. Uber die Organisation und Entwickelung von Bacillus rossii Fabr. Sitzb. d. Kgl. Akad. d. Wiss. Berlin XVI, pp. 363–374.

[3] **Stockard, C. R,** 1908. Habits, Reactions and Mating Instincts of the Walking-stick, Aplopus mayeri. Publ. No. 103 Carnegie Inst., Washington, pp. 43–59.

Coccidae of Boulder County, Colorado.—Mr. D. B. Thurston has recently brought me two species new to the list, collected in Boulder this fall. These are *Aulacaspis rosæ* (Bouché), on cultivated *Rubus*, and *Pulvinaria innumerabilis* (Rathv.) on maple. The *Pulvinaria* has been known here for some years, but by some oversight I failed to obtain specimens before. From the *Pulvinaria bigeloviæ* on *Chrysothamnus*, already recorded, I bred a parasite, which has now been identified by Doctor Howard as *Coccophagus immaculatus* Howard. In his Revision of the Aphelininæ Howard reports *C. immaculatus* only from *Eriococcus azaleæ*, in the District of Columbia. It is rather surprising to find it now in the arid west, infesting a coccid of a quite different group. T. D. A. COCKERELL.

A LIST OF THE APHIDIDÆ OF ILLINOIS, WITH NOTES ON SOME OF THE SPECIES

By JOHN J. DAVIS, *Office of the State Entomologist, Urbana, Illinois.*

(*Continued from p. 419*)

In the first part of this paper (Jour. Econ. Ent., Vol. III, Oct., 1910, p. 410) *Pemphigus corrugatans* Sirrine was questionably listed from Illinois. I have since had an opportunity, through the courtesy of Mr. J. T. Monell, to examine cotypes of *P. corrugatans* in Monell's collection and find that my Le Roy specimens are not that species. Plate 31, figures 1 and 2 are camera lucida drawings of the wing and antenna from the cotypes mentioned above. The label on the slide examined is as follows,—"454[xa] cotypes *Pemphigus corrugatans.* Winged adults, pupa, and larvæ of II? From curled colored leaves of *Cratægus coccinea* var. I. A. C. 6–26–93. In balsam. F. A. S." Plate 31, figures 3 and 4 were drawn from winged viviparous females of a *Pemphigus* corrugating the leaves of *Cratægus* sp. at LeRoy, Ill., July 7, 1907. This latter may be Fitch's *P. pyri.*

[d]*Aphis apocyni* Koch: Thomas 8th Rept. St. Ent. Ill. (1880), p. 94. The *Apocynum* aphis characterized by Thomas is probably not Koch's *apocyni* and it is still to be proven that the European species occurs in America. First reported by Thomas.

**A. asclepiadis* Fitch: Oestlund, Bull. Geol., and Nat. Hist. Surv. Minn. No. 4 (1887), p. 60. A very common species on *Asclepias.*

A. atriplicis Linn.: Hayhurst, Annals Ent. Soc. Amer., Vol. II (1909), p. 88, figs. Common on *Chenopodium album* throughout the state, especially common in southern Illinois. First reported by Monell.

A. avenæ Fab.: Pergande, Bull. Div. Ent., U. S. D. A., No. 44 (1904), p. 5, figs. A common wheat aphis but rarely destructively abundant. First reported by Forbes.

A. bakeri Cowen: Gillette, Jour. Econ. Ent., Vol. I (1908), p. 364, figs.; Davis, Annals Ent. Soc. Amer., Vol. I (1908), p. 259, figs. A common species throughout the state on red clover. First reported by the writer.

A. brassicæ Linn.: Weed, Insect Life, Vol. III (1890), p. 289, 1 fig.; Sanborn, Kans. Uni. Sci. Bull., Vol. III (1904), p. 54, 1 fig. Our most generally destructive aphis of the vegetable gardens, and a most difficultly controlled one in the commercial gardens, the expenses of fighting the aphis soon using up the small profit which is to be made. First reported by Thomas(?).

**A. brevis* Sand.: 13th Ann. Rept. Del. Agr. Expt. Sta. 1901 (1902),

p. 157, 2 figs. Common in Central Illinois on the red haw (*Cratægus coccinea.*)

ᵗ*A. carduella* Walsh: Oestlund, Bull. Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 59. First reported by Walsh. I am unacquainted with this species.

**A. cardui* Linn.: Oestlund, Bull., Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 65. A very common species on the purple thistle, invariably attended by ants (*Formica* sp.).

ᵗ*A. cephalanthi* Thos.: Davis, Annals Ent. Soc. Amer., Vol. II (1909), p. 40, figs. Not uncommonly injuriously abundant on the button-bush shrub (*Cephalanthus occidentalis*), which is often used in ornamental plantings. It usually becomes most abundant in the fall of the year. First reported by Thomas.

**A. cerasifoliæ* Fitch: Oestlund, Bull. Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 51. A serious pest of *Prunus pennsylvanicus*, a shrub commonly planted in parks, and living on the undersides of the leaves, curling them badly, and thus seriously disfiguring the natural beauty. I have found them so abundant as to disfigure every leaf on a clump of these shrubs and to cause the leaves to turn brown and often fall off in midsummer.

**A. coreopsidis* Thos.: 8th Rept. St. Ent. Ill. (1880), p. 59, figs.; Oestlund, 14th Rept. Geol. and Nat. Hist. Surv. Minn. (1886), p. 38, (*A. frondosæ*). Last fall (1909) this species became very abundant at Oak Park, Ill., infesting the stem, leaves, flowers, and flower stalks, principally the two latter, of *Bidens vulgata*, and this fall (October 3, 1910) I found it rather common on *Bidens bipinnata* at Anna, Illinois. Infested plants in confinement were continually watched until the plants and aphids were killed by the cold, with no sign of an oviparous generation. Noticing the marked resemblance between the descriptions of *Siphonophora coreopsidis* Thos. and *A. frondosæ* Oestl., I wrote Professor Oestlund who kindly sent me a mounted specimen of his species. I have thus been able to positively identify my Oak Park specimens as the species described as *A frondosæ.* Mr. Monell has sent me specimens from *Coreopsis* collected in St. Louis, which he determined as *A. coreopsidis* and also a copy of the original type color notes. From all these sources I have studied and compared my species and conclude that the two species, *A. frondosæ* and *A. coreopsidis*, are synonymous. In all specimens the color notes and habits agree quite well. Mr. Monell's specimens were smaller but the relative antennal measurements agree with my specimens excepting in some specimens the length of filament VI is longer, but this appears to be quite variable and can hardly be considered of specific value. Camera lucida drawings, of

the antenna, cornicle and style of the winged viviparous female are given in Plate 32, figures 11, 12, and 13, respectively.

I herewith give antennal measurements which I have made:

Data on slide	Sensoria			Antennal lengths in mm.						
	III	IV	V	I	II	III	IV	V	VI base	VI filament
Aphis frondosæ 8-30-'03 O. W. Oestlund Coll.	11	8	4	0.0652	0.0570	0.3749	0.2282	0.2200	0.1141	0.4727
	11	7	3	0.0652	0.0570	0.3830	0.2526	0.2282	0.1059	0.4645
Oak Park, Ill. On Bidens vulgatus 27th Sept. '09, Davis	12	6	4	0.0733	0.0570	0.3423	0.2282	0.2282	......	......
	12	7	4	0.0733	0.0570	0.3586	0.2282	0.2119	......	......
Oak Park, Ill. On Bidens vulgatus 27th Sept. '09, Davis	11	8	2	0.0652	0.0489	0.3423	0.2282	0.2119	0.1141	0.4564
	11	7	3	......	......	0.3586	0.2445	0.2119	0.1059	0.4482
Oak Park, Ill. On Bidens vulgatus 27th Sept. '09, Davis	......	......	......	......	......	0.3749	0.2363	0.2119	0.0978	0.4401
	......	......	......	......	......	0.3586	0.2200	0.2282	0.0896	0.4401
Oak Park, Ill. On Bidens vulgatus 8th Oct. '09, Davis	11	8	4	......	......	0.3749	0.2852	0.2445	0.1059	......
	12	8	4	......	......	0.3586	0.2934	0.2526	0.1141	0.4238
684x, St. Louis, Mo. On Coreopsis 25th July '08. J. T. Monell coll.	13	6	5	0.0570	0.0489	0.2771	0.1793	0.1793	0.0733	0.4645
	15	7	3	0.0570	0.0489	0.3015	0.1793	0.1711	0.0896	0.4492
684x, St. Louis, Mo. On Coreopsis 25th July '08, J. T. Monell coll.	14	6	4	......	......	0.2771	0.1874	0.1793	0.0815	......
	......	......	......	......	......	0.2852	0.1956	0.1793	0.0815	0.4645
684x, St. Louis, Mo. On Coroepsis 25th July '08. J. T. Monell coll.	......	......	......	......	......	......	0.1956	0.1793	0.0815	0.3993
	......	......	......	......	......	......	......	......	......	......

[d]*A. cornifoliæ* Fitch: Cat. Hom. N. Y., 1851, p. 65; Oestlund, Bull. Geol. and Nat. Hist. Surv., Minn., No. 4 (1887), p. 53. This species has often been confused with the more common *Aphis* on *Cornus*, *A. helianthi*. In his original description of *cornifoliæ* Fitch says, "Apterous females black," and Oestlund describes the color of the abdomen of the winged viviparous female as "dark brown." I have received from Mr. Monell a note on this species, an abstract of long color notes made by Mr. Th. Pergande. I copy in full as received from Mr. Monell.

"315[x] On Cornus lvs. Maryland, May 26-27, '85 (Abstract of long color notes). *Winged:* — Hd. and thorax, nectaries and tail black. Abdomen dark brownish, almost blk. Wings pale dusky. *Apterous.* Dull blk., the abdomen somewhat brownish. *Pupa.* Hd. and thorax dark greenish covered with fine mealy grayish excretion. Abdomen greenish brown with grayish excretion, often two pale distinct stripes of excretion on dorsum. Wing pads dull yellowish.

"This is all *essentials* of color notes verbatim — from Th. Pergande. J. T. Monell."

Mr. Monell very kindly mounted some of the remains (from alcohol) of the specimens from which these notes were made, but they are so shrunken as to be of little value in working out the characters.

The species recently referred to by Professor Gillette as *Aphis cornifoliæ* (Jour. Econ. Ent., Vol. III, Oct. 1910, p. 405) is not, in my opinion the true *cornifoliæ*, but rather the *helianthi* of Monell. This species has never been positively reported from Illinois, all records of the occurrence of *cornifoliæ* in this state apparently referring to the migrant form of *helianthi*.

**A. cratægifoliæ* Fitch: Sanborn, Kans. Uni. Sci. Bull. Vol. III, No. 1 (1904), p. 53, 1 fig. A common species on *Cratægus* in the Chicago parks. It curls the leaves and is often injuriously abundant.

†*A. folsomii* Davis: Ent. News, Vol. XIX (1908), p. 143, 1 pl. Common at Urbana and Chicago attacking Virginia creeper. First reported by the writer.

A. forbesi Weed: Sanderson, 12th Ann. Rept. Del. Agr. Exper. Sta. f., 1900 (1901), p. 143, 6 figs., 1 pl. Common throughout the state, sometimes a serious pest. First reported by Forbes.

A. gossypii Glov.: Pergande, Insect Life, Vol. 7 (1895), p. 309. One of our most common and destructive aphids. In the western part of the state in the melon fields, they do much damage annually. In greenhouses they are often very injuriously abundant on cucumbers as well as on althæa, Hibiscus and Easter lily, especially in more or less neglected houses. First reported by Forbes (as *cucumeris*).

**A. houghtonensis* Troop: Ent. News, Vol. XVII (1906), p. 59, 3 figs. This species was found very common, curling the leaves of gooseberry shrubs growing wild at Aurora, Ill., June 17 and 22, 1910. The drawings by Mr. Heidemann in the article cited above represent the general characters of the species exceedingly well. The antenna of the winged viviparous female, showing the number and position of the sensoria, is illustrated in Pl. 31, fig. 5.

A. helianthi Monl.: Bull. U. S. Geol. and Geog. Surv., Vol. V (1879), p. 26; Weed, Psyche, Vol. V (1888), p. 123. This aphis is very common on various species of *Helianthus*, especially *H. grosseserratus*, *H. divaricatus*, and *H. annuus*. The green aphis so common on *Cornus* leaves in spring and fall is apparently the same species, and not the *A. cornifoliæ* of Fitch as has been so commonly supposed. See discussion above under *cornifoliæ*. Mr. Monell, who has spent much time studying *helianthi*, both on *Helianthus* and on *Cornus*, is also of the opinion that the green *Aphis* on Cornus is the spring and fall form of *A. helianthi*. First reported by Weed (as *cornifoliæ*).

†*A. illinoisensis* Shimer: Prairie Farmer, Vol. 18, No. 20, Nov. 17, 1866, p. 316. Although not positively proven, it is my opinion

that this species is identical with that described in 1880 by Doctor Thomas as *Macrosiphum (Siphonophora) viticola.* Shimer's description agrees in every respect with the well known *viticola*, excepting the statement about the "tubercles" (-cornicles?) and in this Shimer has contradicted himself, for while in the description he says "tubercles about one half the length of the tarsi," later in a discussion he speaks of the "horny tubes," in dried specimens, being about twice the length of the tarsi. Inasmuch as the original description of this species is inaccessible to nearly every worker, I consider it of importance to quote verbatim the description as given in the *Prairie Farmer*.

"A New Grape Aphis

"By Henry Shimer, M. D.

"*Larva* brown, anteriorly darkest. Green at first.

"*Pupa* brown. Rudimental wing and collar slightly tinged with green.

"*Imago* black. Thorax deep black. Abdomen brownish, transversely rugous, beneath, *i. e.*, segments beneath conspicuous; tubercles about one half the length of the tarsi, cylindrical, around the base of which, somewhat distant, the latter margins of the posterior abdomen are conspicuously elevated. Legs black. Anterior femur above lower part of the anterior and middle tibia, premuscus and base of wing nervures grey. Antennæ black. Setiform attaining the basal fifth of the stigma of the expanding wings. The first joint prominent, thick, sub-cylindrical, bevel margined on the upper end. Second shortest, not half the diameter of the first, but decidedly thicker than the following which gradually tapers to the pointed end. Third joint very long, longest, obclavate, the next three gradually shortening successively, the terminal abruptly smaller, setiform almost as long as the third. Eyes black, globular, prominent. Tibia; hairy, somewhat curved. First tarsal joint thick, not easily distinguishable from the tibia; second curved downward long and much tapering from the unguis toward the articulation. Wings hyaline, producing prismatic colors in the sunshine. Anterior wing long, the base acute angled from the middle. Exterior end rounded, in life erect, folded together, perpendicularly over the back, the posterior margin above. Nervures black. The terminal third of the narrow costal and sub-costal space filled with an opaque buff brown narrow elongate, falcate spot. Punctum marginal, about six times as long as wide, black on the posterior border, acute, obliquely pointed at each end tapering internally into the cubitus, and externally into the costal border, from the base of the terminal fifth. From the obtuse angle thus formed at the base of the terminal fifth springs the much curved intercalor stigmatic vein, being curved in the first part of its course — a true parabola with the principal vertex in the carpus, the third discoidal, the three branching vein arises from the internal point of the opaque space, second and first simple, the latter terminating in a tumeaction of the posterior marginal, a narrow elongate conspicuous vittla mostly internally from its extreme origin; a few long, very much attenuated, tapering acute capillary hairs arise from the third discoidal, below the first branch.

"Posterior wing small more pointed, obliquely incised on the anterior margin at the outer end, the sub-marginal vein also deflected parallel and very close to the incised border, decidedly closer than at the middle of the wing and terminating at the apex. Length to tip of wings, .14 inch, of body, .05, anterior wings, .10, antennæ, .05."

Following this description Doctor Shimer gives notes on the habits, which agree with those of *M. viticola*, and the predaceous and parasitic insects of his species. He also discusses at some length on the differences between this and the European *A. vitis* Scop. At the end he adds a note, as follows.

"Note — Since writing the above I have seen this insect on wild grape and Mr. Walsh has informed me that he has examined carefully, some dried specimens

I sent him and that they were perfectly identical with the insect he saw, when he published for it Scopolis Cypeosis. With doubt he referred it to Aphis vittis Scopoli, P. Ent. Soc. vol. 1. There is no specific identity between this and the foreign insects as appears from the above description made from a thorough examination of hundreds of living insects, and as it is found in various parts of the state I would propose for it the specific name, illinoisensis."

[t]*A. impatientis* Thos.: 8th Rept. State Ent. Ill. (1880), p. 98. First reported by Thomas and not since reported in literature except in catalogues. I am unacquainted with the species.

**A. loniceræ* Monl.: Bull. U. S. Geol. and Geog. Surv., Vol. V, No. 1 (1879), p. 26; Oestlund, Bull. Geol. and Nat. Hist. Surv., Minn., No. 4 (1887), p. 55. This interesting and peculiar aphid I have taken but once, namely at Oak Park, Ill., July 16, 1910, on *Lonicera* sp. At this time only wingless were found, and they were extremely abundant on the tender terminal shoots and leaves, more commonly on the former. The newer leaves have the sides curled upwards forming a pseudogall within which the aphids were also found. The colonies and individual aphids are covered with a heavy pulverulence. When the *Lonicera* shrub was examined a second time (23 Aug., 1910), only three immature individuals were found. The species is neither a typical *Aphis* nor *Chaitophorus* (in which latter genus Thomas placed it), but it unquestionably fits better in the former genus. Camera lucida drawings of the antennæ, hind tibia and tarsus cornicle, style and head of the wingless viviparous female are given in Plates 31–32, figures 6, 7, 8, 9 and 10, respectively.

[t1]*A. lutescens* Monl.: Bull. U. S. Geol. and Geog. Surv., Vol. V (1879), p. 23. I have taken this species twice in the vicinity of Chicago, on *Asclepias*. First reported by Monell.

A. maidis Fitch: Davis, Tech. Bull. Bur. Ent., U. S. D. A., No. 12, pt. VIII (1909), p. 144. Common on various weeds and grasses as well as on corn, broom corn, and sorghum, throughout the state. On the three cultivated plants mentioned it is often injurious, particularly so on broom corn where it discolors the broom, thus damaging the quality of brush. First reported by Thomas.

[t]*A. maidi-radicis* Forbes: 18th Rept. St. Ent. Ill. (1894), p. 58, figs.; Davis *loc. cit.* p. 123. One of the most destructive corn pests in Illinois; also of prime importance as an aster insect, having been found killing thousands of plants in single fields of asters in the vicinity of Chicago. First reported by Walsh.

**A. medicaginis* Koch: Thomas, 8th Rept. St. Ent. Ill. (1880), p. 101. This has proven a very important enemy of the black locust, which is grown extensively in the Chicago parks as shrubbery. The lice cluster on the tender terminal shoots and may become so abun-

[1] Illinois one of the type localities.

dant as to blacken them, not only stunting the growth, but often completely killing these tender branches.

[t1]*A. middletoni* Thos.: 8th Rept. St. Ent. Ill. (1880), p. 99; Vickery, Bull. U. S. Dept. Agr., Bur. Ent. No. 85, Pt. VI (1910), p. 113. I have never taken this species. First reported by Thomas (?).

**A. neilliæ* Oest.: Bull. Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 59. This species has not, I believe, been reported since the original description, Professor Oestlund having found it in Minnesota on *Neillia opulifolia*, the common pine bark, now known as *Physocarpus* (*Spiræa*) *opulifolius*, a shrub much used in ornamental plantings. Last year (1909) at Oak Park, Ill., it became so abundant that the leaves were badly curled and the shoots stunted or even killed. The winged viviparous female is well characterized by the very tuberculate antennæ, brown wing veins, conspicuous black stigma and dark brown to blackish body color. The sexes were first observed October 9, and from the numbers of eggs already deposited they had been there for several weeks. At this time the leaves and shoots were covered with the aphids and dozens of pairs were observed *in copula*. The sexes are interesting in that the male is wingless as is also the oviparous female. These males are very small, brownish red to black and the ocelli absent. The oviparous females are entirely black. Eggs are laid by the hundreds in the crevices formed by the leaf petiole and stem, and by the dormant buds. This spring (1910) the eggs commenced hatching March 30, a few days after the leaves appeared.

[d]*A. nerii* Fonsc.: Thomas, 8th Rept. St. Ent. Ill. (1880), p. 95. It is probable that Thomas found the species which he questionably referred to *nerii* in Illinois, although he does not so state. The record here is questioned.

**A. persicæ-niger* Smith, E. F.: Gillette, Jour. Econ. Ent. Vol. I (1908), p. 308, figs. and col. pl. A common pest of the peach.

A. pomi De G.: Gillette, *loc. cit.* p. 303. A common and often destructive pest of the apple in Illinois; also occasionally found injuring the tender shoots of the flowering or Japanese quince (*Cydonia japonica*) in the Chicago parks. First reported by Fitch.

**A. œnotheræ* Oestl.: Bull. Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 62. It is with some doubt that I record this species from Illinois. Specimens collected in Chicago on *Œnothera biennis* agree exactly with the description and habits as given by Oestlund except in the following: In addition to the marginal row of black spots the Chicago specimens have transverse dusky markings on

[1] The indications are that Thomas made his type collections in Illinois, but he does not say positively.

the three last abdominal segments. The cornicles are only two to two and a half times the length of the tarsi. The style is pale or pale greenish and not dusky or black as given in the original description.

*A. *populifoliæ* Fitch: Cat. Homopt. N. Y. 1851, p. 66. This very interesting species was found infesting the tender terminal shoots and under surfaces of the leaves of the quaking aspen (*Populus tremuloides*), June 27, 1910, in one of the Chicago parks. All of the *P. tremuloides* in this park had recently been secured from their native habitat in Indiana, just across the state line and not far from Chicago. The same species was also taken on the common Carolina poplar (*P. deltoides*) in a Chicago nursery, June 30, 1910. August 23, the trees so heavily infested nearly two months before were visited, but not a single aphis could be found. Through the kindness of Mr. J. T. Monell I have had the privilege of examining specimens in his collections of this same species and which he has long considered to be the *populifoliæ* of Fitch. These Monell specimens are labeled "293*x* Washington, D. C., Sept. 30, 1880, *Populus alba*. From Theo. Pergande."

From the brief description given by Fitch it is difficult if not impossible to identify the species with certainty, although one might be led to believe that he was dealing with a species of the genus *Melanoxantherum*. Notwithstanding the slight differences in measurements the aphid in question is possibly the one Fitch was dealing with. *Populifoliæ* Fitch has generally been considered a species of the genus *Chaitophorus* but the one here considered, although showing marked *Chaitophorus* tendencies, is nearest related to the genus *Aphis*.

The *Chait. populifoliæ* as described by Oestlund[1] is clearly not Fitch's species. Through the courtesy of Professor Oestlund, I have examined the species which he described and questionably referred to the *populifoliæ* Fitch. It is a typical *Chaitophorus* and a new species which I propose shall hereafter be known as *Chaitophorus populifoliæ* Oestlund. These two species and a new species on poplar are fully described and discussed in another paper soon to be published and it is therefore sufficient to give here simply a brief description of the species which is being considered by the writer as Fitch's *populifoliæ*.

Wingless viviparous female.—Entire body dark reddish brown with very conspicuous white flocculent patches, namely a row on each side of the abdomen and two more or less regular longitudinal rows on the dorsum, one on each side of the median line. Under surface of abdomen with a large patch of whitish pulverulence. Antennæ not reaching to the base of cornicles; segment III longest, it being about twice the length of IV, IV and V subequal, base VI about half the length of V and a third the length of the filament. Legs with femur black excepting extreme base, tibia whitish except distal ends which are black and the tarsus black. Style black and moderately long, nearly one half the length of cornicles. Cornicles black, rather long, and cylindrical.

[1] Bull. Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 38.

Winged viviparous female.—Head and thorax black. Abdomen dark reddish brown with the posterior end darkening to blackish. Abdomen with a row of three small but conspicuous white pulverulent spots on each side of the median and anterior to the cornicles; also many other white pulverulent dots on the abdomen, but they are rather inconspicuous and easily rubbed off. Antennæ black; not reaching the base of the cornicles; relative lengths of antennal segments as in wingless; segment III with about 14 circular sensoria, more or less in a row, and the usual ones at distal ends of V and base VI. Legs with the femur blackish excepting basal end, tibia whitish or pale brownish with the distal one third or one half blackish, tarsus black. Wing veins dark, stigma blackish. Style black. Cornicles black, cylindrical, and reaching to the base of the style.

**A. prunifoliæ* Fitch: 1st Report Insects N. Y. (1855), p. 122. I have taken this species but once, namely on plum at Niles Center, Ill., June 18, 1908.

**A. sorbi* Kalt.: Sanderson, 13th Rep. Del. Agr. Exp. Sta., 1901 (1902), p. 149, 4 figs. A rather uncommon species, which I have taken only in northern Illinois.

†*A. quercifoliæ* Walsh: Proc. Ent. Soc. Phil. Vol. I (1862), p. 298. I am unacquainted with this species. First reported by Walsh.

A. rufomaculata Wils.: Ent. News, Vol. XIX (1908), p. 261. A serious pest of the greenhouse chrysanthemum. First reported by the writer.

**A. sambucifoliæ* Fitch: Sanborn, Kans. Univ. Sci. Bull. Vol. III, No. 1 (1904), p. 52, 2 figs. A very common species attacking the, ornamental elder in the Chicago parks, but is not a serious pest. The sexual forms, the small winged males, and the wingless oviparous females, appear in September and October in northern Illinois, usually becoming mature the latter part of September.

†*A. salicicola* Thos.: 8th Rep. State Ent. Ill. (1880), p. 63 (Siphonophora). A common willow aphis in Illinois. First reported by Thomas.

†*A. setariæ* Thos.: 8th Rep. State Ent. Ill. (1880), p. 56; Oestlund Bull. Geol. and Nat. Hist. Surv. Minn. No. 4 (1887), p. 67. A very common species, occurring throughout the state. First reported by Thomas.

**A. spiræella* Schout. ?? In the JOURNAL OF ECONOMIC ENTOMOLOGY for October, 1910 (p. 404), Professor Gillette has noted this species as occurring in America. It has been very abundant and destructive on *Spiræa vanhouttei* and *S. salicifolia* in many parts of Illinois and after a careful study and comparison with the original description of *spiræella*[1] I consider it distinct but will leave it as above until specimens of the European species can be obtained (my efforts in this connection have thus far been useless) for comparison. The most noteworthy differences are in the antennal lengths which

[1] Zoölogisches Anzeiger, Vol. 25 (1902), pp. 656–657.

in all my winged specimens are exceptionally constant and the fact that *spiræella* rolls the leaves and as Schouteden says, "Die Blattmitzbilbungen, welche *Aphis spiræa* [=*spirætella*] erzeugt, sind bereits von verschiedenen Cecidiologen beobachtet worden."[1]

The following table of comparison may be of interest:

Winged viviparous female.	
A. spiræella. Schout.	*A. spiræella* ?? from Illinois.
Under rolled leaves of *Spiræa ulmaria.*	Colonizing on the tender terminal shoots and leaves of *S. vanhouttei* and *S. salicifolia.*
Abdomen green, usually marbled.	Abdomen pale green.
Head and thorax black.	Head and thorax black.
Antennal measurements, III =longest. IV =three-fourths of III. V =one-half of III. (VI) =one-half of (VII). (VII) =about three-fourths of III.	Antennal measurements, III =four-fifths of (VII). IV =three-fourths of III. V =three-fourths of III. (VI) =one-third of (VII). (VII) =longest.
Beak reaching to hind legs.	Beak reaching to second pair of legs.
Style half the length of cornicles, dark green.	Style more than half the length of cornicles, black.
Cornicles black, paler at tip.	Cornicles black.
Wings transparent, wing veins (Wurzel und Unterrandader) greenish, cubitus twice or only once branched.	Wings transparent, wing veins pale brownish, cubitus twice branched.
Last segment of abdomen sometimes marked or striped with black.	Sometimes with dusky markings on abdomen as given, description below.
Wingless viviparous female.	
Antennæ shorter than body, blackish, third segment pale.	Antennæ shorter than body, segments I and II dusky, III and IV pale, V and VI darkening to black.
Relative antennal measurements about as in winged.	Relative antennal measurements about as in winged.
Legs greenish, tips of femora and tibiæ and the tarsi dark green.	Legs pale greenish white, excepting "knee" joint, tip of tibiæ and tarsi blackish.
Style hairy, nearly half length of cornicles, dark green.	Style moderately hairy, nearly half length of cornicles, black.
Cornicles dark green, black and somewhat thinner at tips.	Cornicles black, gradually narrowing towards the tip.

Winged viviparous female.— Head (Pl. 32, fig. 14) and thorax black, abdomen pale green, and sometimes with a row of three dusky spots on each side anterior to the cornicles, one at the base of each cornicle, and a faint dusky transverse marking on each of the last two segments. Eyes black. Antennæ pale except the two basal segments which are dusky and the distal ends of V and all of VI which are blackish (in some specimens only the basal ends of the segments are pale, the tips being dusky to blackish), not reaching the base of cornicles, filament VI longest, III four fifths of filament VI, IV and V subequal and each about three fourths of III, base VI one third of filament VI; 6 or 7 rather large circular sensoria in a row on segment III, sometimes one or two on IV, and the usual ones at the distal ends of V and base VI (Pl. 32, fig. 16). Wing veins pale brownish, first and second discoidals

[1] *Loc. cit.* p. 657

branching at one third the distance from the tip of the wing to where the third branches (Pl. 32, fig. 17). Legs pale brownish, excepting the distal ends of femora, tibiæ and all of tarsi which are blackish. Thoracic tubercle prominent. Smaller but similar tubercles along the sides of the abdomen. Cornicles black, cylindrical, and nearly one half longer than style (Pl. 32, fig. 18). Style black (Pl. 32, fig. 19).

Measurements.— (From specimens mounted in balsam.) Length of body, 1.2–1.59 mm., average, 1.39 mm.; width, 0.58–0.83 mm., avg. 0.64 mm.; length of wing, 2.1 mm.; width, 0.87 mm.; antenna, I, 0.057; II, 0.049; III, 0.179–0.260, avg. 0.216; IV, 0.131–0.195; avg. 0.160; V, 0.138–0.180, avg. 0.161; VI, base, 0.0815–0.114, avg. 0.098; VI, filament, 0.228–0.293, avg. 0.280; avg. total, 1.101 mm.; length of cornicles, 0.17–0.24 mm., avg. 0.205 mm.; style, 0.105–0.16 mm., avg. 0.14 mm.; hind tarsus, 0.10 mm.

Wingless viviparous female.— Body pale green, head dusky. Eyes black. Antennæ with segments I and II dusky, III, IV, and basal half of V pale, end of V and all of VI blackish; relative lengths of segments as in winged form.[1] (Pl. 32, fig. 15). Legs pale greenish white excepting joints, distal end of tibiæ, and all of tarsi which are blackish. Thoracic and abdominal tubercles as in winged. Cornicles black, very slightly narrowing towards the tip. Style black.

Measurements.—Length of body, 1.39 mm.; width, 0.85 mm.; antenna, I, 0:057; II, 0.049; III, 0.20–0.29, avg. 0.24; IV, 0.13–0.24, avg. 0.17; V, 0.14–0.21, avg. 0.17; VI, base, 0.098; VI, filament, 0.235–0.277, avg. 0.255; avg. total, 1.039 mm.; cornicles, 0.305 mm.; style, 0.175 mm.; hind tarsus, 0.115 mm.

The winged male may be recognized by the numerous sensoria on segments III, IV, and VI base, of the antennæ; by its smaller size; and the greenish brown abdomen.

The wingless oviparous female is pale greenish yellow to yellow and the hind tibiæ are swollen and bear many sensoria.

[d]*A. symphoricarpi* Thos.: 8th Rep. State Ent. Ill. (1880), p. 99; Oestlund, Bull; Geol. and Nat. Hist. Surv. Minn. No. 4 (1887),, p. 50. I have frequently searched for this species in Chicago and vicinity without success. There is no record of its occurrence in Illinois other than in Hunter's compiled list.

[t2]*A. vernoniæ* Thos.: 8th Rep. State Ent. Ill. (1880), p. 97; Sanborn, Kans. Univ. Sci. Bull., Vol. III, No. 1 (1904), p. 57, 2 figs. First reported by Thomas.

**A. viburnicola* Gill.: Ent. News, Vol. XX (1909), p. 280, 1 pl. Common on snowball (*Viburnum opulus*) in the vicinity of Chicago.

[t]*Cerosipha rubifolii* Thos.: Sanborn, Kans. Univ. Sci. Bull., Vol. III (1904), p. 44, figs. I place this species in Del Guercio's genus *Cerosipha* on the authority of Mr. H. F. Wilson. I have not seen the description of this genus, which Mr. Wilson has kindly informed me is in "Nuove Relazioni R. Stazione di Entomologia Agraria di Firenze, 1900, p. 116." This species is very common in Illinois, curling and injuring the foliage of the cultivated and wild blackberry.

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[1]Exceptions:—one individual had segment VI filament 0.024 mm. shorter than III, and another had VI filament and III of equal length.

[2]Carbondale, Ill., and Fort Dodge, Ia., are the type localities.

Thomas makes no mention as to the type locality of this species, but supposedly it was collected by him in Illinois.

Toxoptera graminum Rond.: Hunter, Bull. Univ. Kans., Vol. IX, No. 2 (1909), 221 pp., 66 figs., 9 pls., 3 col. pls. Ordinarily this species does not become injuriously abundant in Illinois, but occasionally it damages grain in southern and parts of western Illinois. First reported by Forbes.

**Hyadaphis pastinacæ* Linn.: ? Monell, Bull. U. S. Geol. and Geog. Surv., Vol. V, No. 1 (1879), pp. 26–27. (*Rhopalosiphum salicis*). Weed, Trans. Amer. Ent. Soc., Vol. XX (1893), p. 297 (*H. salicis*). This species I have taken on *Zizia aurea*, garden parsley, and *Salix*, in Illinois. On the parsley they became so abundant as to noticeably damage it. According to Schouteden the following synonyms have already been recognized,—*aegopodii* Scop., *capreæ* Fabr., *cicutæ* Koch, *umbellatorum* Koch: It is with some hesitation that I add another species (*H. salicis* Monell) to the already long synonomy. All of the *Hyadaphis* which I have found on *Salix* agree well with the descriptions of *pastinacæ* and with the specimens taken on *Zizia aurea* and parsley. Also Mr. Monell has kindly made a careful examination of the type slides and in a letter dated October 14, 1910, he says, "I have just looked at it [type slide of *H. salicis*, collected June 15, 1878] under a ¾ objective, and I cannot see the tubercle [referring to a small acute tubercle on the dorsum of the penultimate abdominal segment and projecting caudad, a character which appears to be found in no other species of this genus] on specimens mounted back up but luckily one specimen is mounted sideways and I can see the 'horn' plainly. My recollection is this was quite a common species in 1878–1879, but now we seem to find only isolated specimens in colonies of the *Ch. viminalis*." In an earlier letter (October 6, 1910) Mr. Monell gives some interesting compiled data which I copy verbatim. "This *S. capreæ* [=*pastinacæ*] on willow and *Umbelliferæ* does not seem to be an 'alternation' of food plants as witness these dates —

On willow.

In April, Kaltenbach's Monograph.
June 11, '77. Willow, Pergande notes, St. Louis, Mo.
June 15, '78. 150*o* St. Louis, Mo. Old types of *Rh. salicis*.
May 25, '86. 341*x* St. Louis, Mo.
Oct. 1, '10. Collected by Davis at St. Louis, Mo. [winged].
[Aug. 4, '09. Oak Park, Ill. Apterous only.]

On *Umbelliferæ*.

May 22, '07. On *Thaspium*, 539x, St. Louis, Mo. Apterous only.
June 19, '07. On *Heracleum*, 548, St. Louis, Mo. Apterous only.
July 1, '10. On garden parsley, 830x, Chicago, Davis, Apt. and winged.

Mar. 4, '91. *Aphis pastinaci* on celery, Washington (State?). Insect Life, Vol. IV, p. 213.

[Oct. 1, '08. On *Zizia aurea*, Chicago, Ill. Apt. and winged.]

The following average measurements from three collections may be of interest:

Collection data	Antennal measurements in mm.					Sensoria
	III	IV	V	(VI)	(VII)	
Garden parsley, July 1, 1910, Chicago, Ill.	0.34	0.13	0.13	0.13	0.16	Sensoria only on III.
Zizia aurea, Oct. 1, 1908, Chicago, Ill.	0.34	0.10	0.08	0.08	0.12	Sensoria on III and IV.
Willow, Oct. 1, 1910, St. Louis.	0.44		0.08	0.08	0.10 broken off	Sensoria on III and IV

In his description of the winged male and wingless oviparous female of *H. salicis* in Transactions of the American Entomological Society, Vol. XX (1893), p. 297, Weed mentions the characteristic abdominal tubercles referred to above. Camera lucida drawings of the tubercles or "horns" are given in Plate 32, figure 20 from the wingless viviparous female (a = tubercle; b = style) and figure 21 from the winged viviparous female, both drawn to the same scale.

Oestlund's *H.* (*Siphocoryne*) *archangelicæ* may also prove to be a synonym of *pastinacæ.*

**Hyalopterus arundinis* Fabr.: Oestlund, *loc. cit.* p. 44 (*phragmitidicola*). This species is exceedingly common in northern Illinois, where it thickly colonizes the leaves, usually on the upper surfaces, and along the mid-rib of *Phragmitis phragmitis*, which grows abundantly along country roadsides.

Rhopalosiphum berberidis Fitch: Davis, Annals Ent. Soc. Amer. Vol. I (1908), p. 254, figs. A common and often abundant species, occasionally in such numbers as to injure the barberry (*Berberis vulgaris*), a useful shrub in ornamental plantings. First reported by the writer.

R. nymphaeæ Linn.: Jackson, Ohio Naturalist, Vol. 8 (1908), p. 243, 1 plate. (*Aphis aquaticus*). In conservatories it often becomes quite troublesome on *Philotria canadense* and calla. Out-of-doors it is a common aphid on water plants such as *Nymphæa, Sagittaria* and *Lemna*. First reported by the writer.

**R. rhois* Monl.: Sanborn, Kans. Univ. Sci. Bull., Vol. III, No. 1 (1904), p. 64, figs. Often becoming exceedingly abundant on ornamental sumach, seriously disfiguring and weakening the plants.

[t]*R. solani* Thos.: 8th Rep. State Ent. Illinois (1880), p. 73. Have never taken this species, but an examination of the types in the State Laboratory of Natural History proves it to be a distinct and good species. First reported by Thomas.

***R. sonchi* Oestl.: 14th Ann. Rep. Geol. and Nat. Hist. Surv. Minn. (1886), p. 34. Found on *Sonchus* rather commonly in northern Illinois.

**R. violæ* Perg.: Can. Ent. Vol. 32 (1900), p. 30. I found this species quite common on cultivated violets in a greenhouse at Peoria, Ill., September 24, 1910, the first and only record we have of its occurrence in Illinois.

[d]*M. achyrantes* Monl.: Bull. U. S. Geol. and Geog. Surv., Vol. V, No. 1 (1879), p. 18. Pergande[1] questionably places [this species as a synonym of *M. mahaleb* and Gillette[2] has considered it the same as *M. persicæ*. I am unacquainted with the species. First reported by Forbes and Hart.

M. cerasi Fabr.: Weed, Bull. Ohio Agr. Exp. Sta., Tech. Ser: Vol. I, No. 2 (1890), p. 111; Gillette, Jour. Econ. Ent. Vol. I (1908), p. 362, col. figs. First reported by Thomas.

M. elæagni Del Guer.: Gillette, Can. Ent., Vol. XL (1908), p. 17, figs. (*M. braggii*); Davis, Annals. Ent. Soc. Amer., Vol. I (1908), p. 251, figs. A common species attacking ornamental Russian olive (*Elæagnus augustifolia*) and *Shepherdia argentea*, and although often becoming quite abundant, seldom injures the plants attacked. First reported by the writer.

M. persicæ Sulz. (=*Rhop. dianthi Schr.*): Gillette, Jour. Econ. Ent., Vol. I (1908), p. 359, col. figs. A very common and often pernicious pest in gardens and greenhouses, those plants which I have found it damaging most being cultivated snap dragon, carnation and ornamental pepper in greenhouses; and cabbage, spinach, and egg plant in the vegetable garden. I have examined what are probably the types of Thomas' *Rhop. tulipæ*, and they prove to be *persicæ* Sulz. First reported by Thomas.

**M. plantagineus* Pass.: I have taken this species on the common plantains (*Plantago rugelii* and *P. major*) on several occasions at Urbana, LeRoy, and Aurora. It lives on the base of the leaf stalks, on the under surface and near the ground, the aphid colonies often being covered with a "tent" of earth and débris constructed by the ants in attendance, usually the common field ant (*Lasius n. americanus*). Its habits are very much like those of the clover aphis (*A. bakeri*). Doctor Mordwilko, to whom specimens were sent, has

[1]Bull. U. S. Dept. Agr., Div. Ent. No. 7 (1897), p. 52.

[2]Bull. Colo. Agr. Exp. Sta. No. 133 (1908), p. 32.

confirmed the writer's determination. I believe this species has not heretofore been reported from the United States.

The following descriptions were made from specimens collected at Urbana, Ill., July 15, and August 7; LeRoy, Ill., June 22; and Aurora, Ill., September 24.

Winged viviparous female.— Head (Pl. 32, fig. 22) and thorax dark, abdomen pale green with a reddish area around each cornicle. Eyes black. Antennæ on frontal tubercles, typical of the genus *Myzus;* subequal to or slightly longer than the body; filament VI longest, it being nearly ¼ longer than III, III nearly 1-3 longer than IV which is subequal with segment V, base VI 1-4 length of the filament or 1-3 length of III; 11–17 circular sensoria, usually more or less in a row on segment III, the usual ones at ends of V and base VI (in one specimen there were two small sensoria on segment IV); slightly imbricated, bare, and dusky to blackish excepting the two paler basal segments and basal end of III. (Pl. 32, fig. 26.) Wings with dark and conspicuous venation, the first and second discoidals branching at a little less than 2-3 the distance from where the third branches, to the tip of wing. (Pl. 32, fig. 25.) Legs pale excepting tarsi which are black. Cornicles pale, reaching to or slightly beyond tip of style, narrowest in middle and the tip very slightly swollen. (Pl. 32, fig. 23.) Style pale, typical of the genus, and about 1-2 the length of the cornicles. (Pl. 32, fig. 24.)

Measurements.— Length of body, 1.27 mm.; width, 0.55 mm.; length of wing, 2.22 mm.; width, 0.80 mm.; antenna, I, 0.065; II, 0.055; III, 0.375; IV, 0.277; V, 0.277; VI, base, 0.130; VI, filament, 0.49; total, 1.669 mm.; cornicle, 0.275 mm.; style, 0.130 mm.; hind tarsus, 0.114 mm.

Wingless viviparous female.— Body cream colored to pale brownish yellow, the abdomen having also a distinct but very slight greenish tint. A small red area at the base of and around each cornicle. The red eyes of the embryonic aphids within the body are visible through the dorsal abdominal wall of the mature female. Eyes brownish black to black. Antennæ concolorous with the body excepting the dusky tip of IV, and also tip of V and all of VI, which are black; slightly longer than length of body, relative antennal lengths as in winged. (Pl. 32, fig. 27.) Legs pale or with a very pale brownish tint, and the tarsi black. Cornicles and style as in the winged.

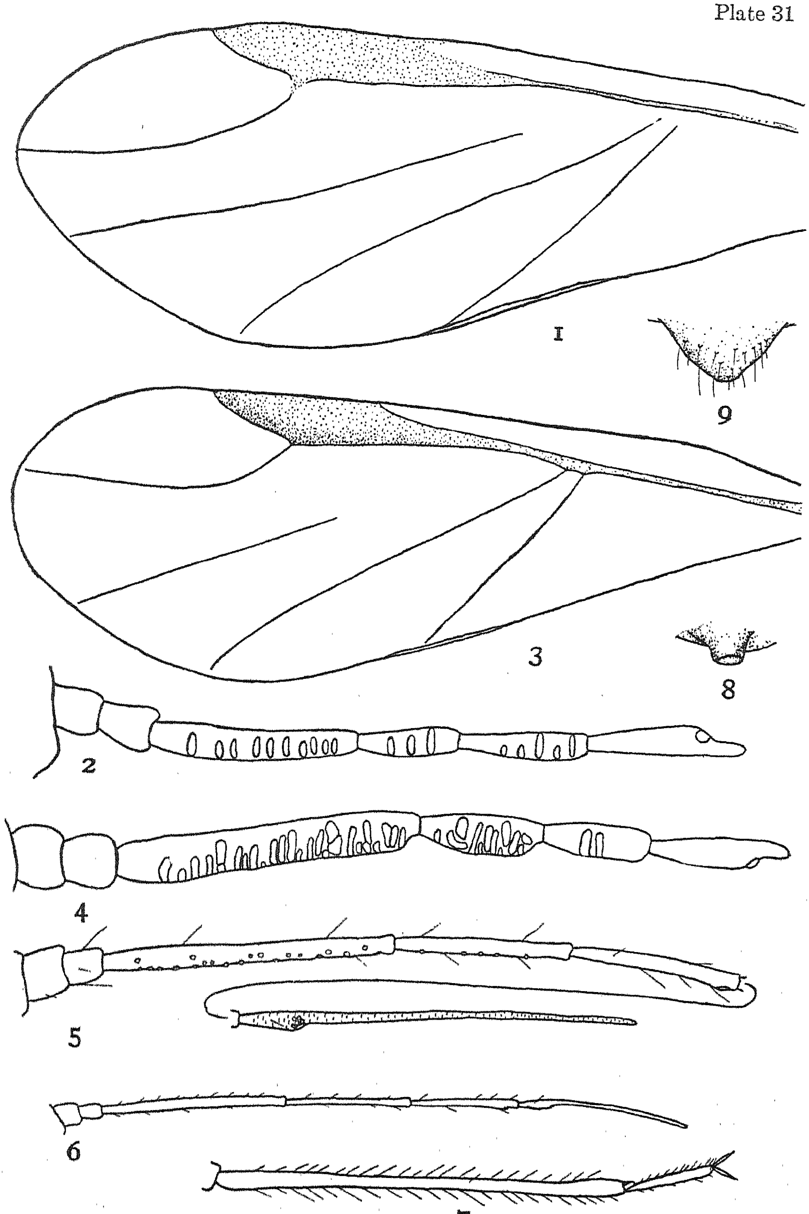
Measurements.— Length of body, 1.6 mm.; width, 1.05 mm.; antenna, I, 0.075; II, 0.57; III, 0.407; IV, 0.277; V, 0.277; VI, base, 0.130; VI, filament, 0.489; total, 1.712 mm.; cornicle, 0.358 mm.; style, 0.135 mm.; hind tarsus, 0.114 mm.

**M. ribis* Linn.: Oestlund, Bull. Geol. and Nat. Hist. Surv. Minn., No. 4 (1887), p. 74. Common throughout the state, and frequently a pest on the cultivated currant.

**M. rosarum* Walk.: Oestlund, 14th Ann. Rep. Geol. and Nat. Hist. Surv. Minn. (1886), p. 30 (*M. potentillæ*). A rose pest commonly found in Illinois on roses in greenhouses. They colonize the tender shoots, sometimes completely covering them and naturally killing the growth.

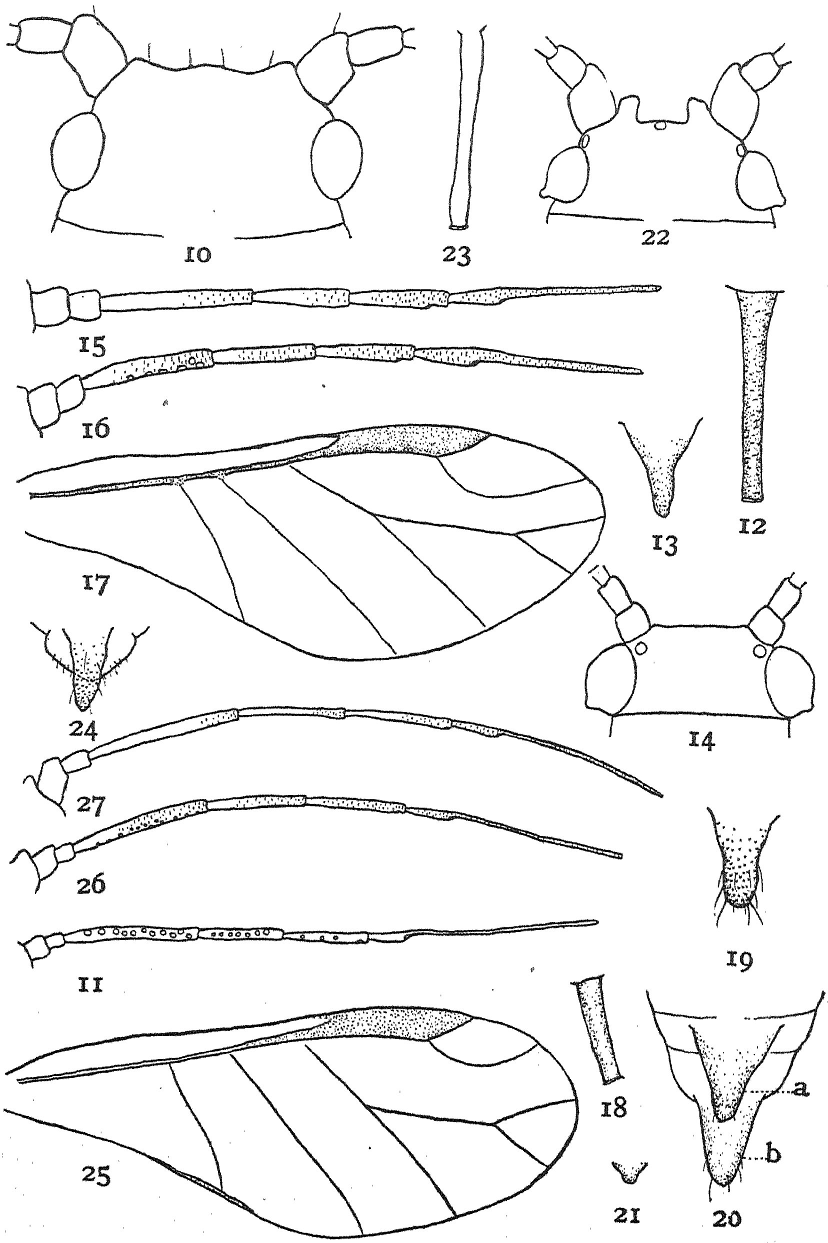
(To be concluded)

Plate 31



Structure of Aphididæ

Plate 32



Structure of Aphididæ

Explanation of Plates 31 and 32.

Pemphigus corrugatans Sirr.—Fig. 1, wing; 2, antenna of winged viviparous female.

P. pyri Fitch (??).— Fig. 3, wing; antenna of winged viviparous female.

Aphis houghtonensis Troop.— Antenna of winged viviparous female.

A. lonicerœ Monl.— Fig. 6, antenna; 7, hind tibia and tarsus; 8, cornicle; 9, style; 10, head of wingless viviparous female.

A. coreopsidis Thos.— Fig. 11, antenna; 12, cornicle; 13, style of winged viviparous female.

A. spirœella Schout. (?) — Fig. 14, head of winged viviparous female; 15, antenna of wingless viviparous female; 16, antenna; 17, wing; 18, cornicle; 19, style of winged viviparous female.

Hyadaphis pastinacœ Linn.— Fig. 20, abdominal tubercle on the wingless viviparous female; 21, on the winged viviparous female.

Myzus plantagineus Pass.— Fig. 22, head; 23, cornicle; 24, style and anal plate; 25, wing; 26, antenna of winged viviparous female; 27, antenna of wingless viviparous female.

Camera lucida drawings, figures 5, 8, 9, 10, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, with a one inch eyepiece and two third objective; 6, 7, 11, 26, and 27 with a two inch eyepiece and two third objective; 17 and 25 with one inch eyepiece and one and one half objective. Figure 3 is drawn to a scale about one third smaller than 1. Figure 2 and 4 are drawn to the same scale.

THE NEW FRENCH EXPORT PLANT INSPECTION SERVICE

By L. O. Howard

On page 76 of the current volume of the Journal of Economic Entomology (February, 1910) occurs an abstract of remarks made by the writer on the subject of European conditions as affecting nursery stock, in which it was shown that the French government had promised to establish a governmental inspection service in France, under the Ministry of Agriculture. These remarks were made at the Eighth Annual Meeting of Horticultural Inspectors at Boston, on December 26, 1909.

Early in November there was received at the Department of Agriculture through the French Ambassador to the United States and the U. S. Department of State, a statement to the effect that the service had been established, and transmitting more or less detailed information from the official journal of the French Republic. Information was conveyed that Dr. Paul Marchal, director of the Agricultural Entomological Station at Paris, had been placed in charge of the work, and the hope was expressed that the service established would be satisfactory to the government of the United States, on the understanding that the arrangement will not affect the right of the United States to examine shipments of living plants, where necessary.

Following this information, a letter was received at the Bureau of Entomology, dated October 27, from Doctor Marchal, and addressed to the writer. Translated excerpts from this letter, which will be of interest to State and Experiment Station entomologists and to horticultural inspectors, may be quoted as follows:

"As you have already been informed by the Minister of Agriculture, I have been officially charged with the delivery of the accompanying certificates upon material exported by nurserymen to the United States, who demand a phytopathological inspection. I myself visited from the 9th to the 13th of October the nurseries in the neighborhood of Nantes, Angers and Orleans. At Nantes and at Angers I was accompanied by Mr. Vuillet, of Rennes, and we examined together a very great number of plots. In spite of all of our care, we have not found any eggs of *dispar*, and in my whole journey I found only four nests of *chrysorrhœa*. Everywhere I have given a description of the insects, and recommended the greatest care. The certificates which I will give will be in accordance with the models enclosed. They will shortly be printed. No. 1 will be in the most demand, and is to be attached to the sendings of nurserymen having plots belonging to them and under their direct care. While the certificate makes mention only of plots, and not of sendings, I reserve for myself the right to make visits at the time of shipment or of packing, or any time when I can form the best judgment. These visits will serve to check an inspection of the plots themselves. I have limited the certificate to the plots without speaking of the sendings on account of the impossibility I would find of inspecting one by one all of the packages which are sent. The important point, aside from the inspection of the plots themselves, is that if the nurserymen know that an inspector can come at any moment they will be much more careful."

"Certificate No. 2 is destined for exporters who have no plots belonging to them or under their direct eye, and it implies at least one visit of inspection for each sending. I have named as inspector for the region of Nantes and Angers, Mr. Vuillet of Rennes, who always does his work with great conscientiousness. I have seen him at work, and I appreciate his competence. In all probability he will also be charged with the region of Ussy, which I intend to personally visit within a few days. My assistant, Mr. Guinaux, will take the region of Orleans. I myself and Mr. LeCerf will attend to the region about Paris. Finally I count on Mr. Poirault, director of the Villa Thuret, at Antibes, a very distinguished biologist and botanist, for the southern region.

"I desire that in future the provisional organization which has been instituted should be completed and become permanent, but in order

to bring this about it is first necessary that the nurserymen themselves should not be obliged to pay the expense, but that a government phytopathological service should be created having a special budget provided by the state. In the meantime, in order to have the plantations more and more healthy, I count upon the instruction which we are giving and upon training in the methods to be employed. We will do our best to make the nurserymen more careful in their operations and to see that they employ the proper means for the destruction of the enemies of plants.

"Around Paris I have found that a certain number of large nurserymen take pains to wash the trees at the time of packing with black soap or with a solution of lysol. They remove thus many winter eggs and Coccidæ which are found on the bark, but this precaution is nearly a certain guarantee that they will not allow a nest of *chrysorrhœa* or an egg-mass of *dispar* to go out. It is unfortunately much more difficult to get such care taken in the region where they produce the plants in enormous quantity and very cheaply, for it is evident that any additional expense will oblige the nurserymen to go out of business. To spread among them a knowledge of *chrysorrhœa* and *dispar*, I have distributed a short circular, with figures representing these insects and particularly the nest of *chrysorrhœa* and the egg-mass of *dispar*."

This movement on the part of the French government is one in the direction of coöperative assistance between France and the United States, and Doctor Marchal's high reputation in this country is in itself a guarantee of the thoroughness of the examinations upon which his certificates will be based.

Two forms of certificates mentioned in his letters are as follows:

(No. 1.) The undersigned, director of the agricultural entomological station of Paris, does hereby certify that the nurseries of M............................. nurseryman at..............................were inspected and that, to his knowledge, the plantations show no indication whatever of any species of insects (especially gypsy moth and brown-tail moth), considered as dangerous, or of any disease able to be transferred to orchards or nursery stock.

THE DIRECTOR OF THE AGRICULTURAL
ENTOMOLOGICAL STATION OF PARIS.

(No. 2.) The undersigned, director of the agricultural entomological station of Paris, does hereby certify that the sendings of M............................. horticulturist at..................................were inspected and that, to his knowledge, they show no indication whatever of any species of insects (especially gypsy moth and brown-tail moth) considered as dangerous, or of any disease able to be transferred to orchards or nursery stock.

THE DIRECTOR OF THE AGRICULTURAL
EXPERIMENT STATION OF PARIS.

The observations mentioned by Doctor Marchal as having been made on the occasion of the trip of himself and Mr. Vuillet to western France and Orleans afford an interesting confirmation of the observations made by the writer in June in the same region. Not a single nest of the brown-tail moth was discovered and no trace of the gypsy moth in any of the nursery-growing regions. In fact, during the past summer, lepidopterous larvæ of all kinds were exceedingly rare in northern France. This, however, need not be taken as a ground upon which to base careless inspection of imported stock the coming winter.

INSECTS OF THE YEAR 1910 IN IOWA

By R. L. Webster

The weather conditions during the past season in Iowa have been exceptionally adapted for the abundance of several insect pests. The warm month of March, followed by continued cool weather, and the long period of drought during the summer, caused many insects to become very common. The insects I will take up in a more or less chronological order, as they were found during the season. The first thing that I have to record, however, has nothing to do with the peculiar weather conditions this year. This is the finding of the clover leaf-weevil in Iowa.

Phytonomus punctatus Fabr. This insect has been gradually working westward ever since its importation from Europe and I have been expecting to find it in Iowa every year. In April, 1910, I spent a few days around Burlington, which is on the Mississippi River in the southeastern part of the state. I found no traces of the insect on the high ground back from the river, but I did find larvæ fairly common in a clover field in the river bottoms, a couple of miles north of Burlington. These larvæ were taken to the insectary at Ames and the beetles were subsequently reared, these emerging May 12th to 24th. So far as I know this is the first occurrence of this insect west of the Mississippi, with one exception, at Vancouver, B. C., which may be an artificial importation. The insect reached Illinois from the east about 1903.

Pegomya fusciceps Zett. On account of the very warm weather in early spring corn planting began very early. But it turned cool again for several weeks and during this period much damage was done by the seed-corn maggot. By the middle of June most of the maggots had matured and the adult flies emerged towards the latter part of that month. The most injury was in the earlier planted fields, where

the corn remained in the ground for some little time before it germinated.

Sphenophorus parvulus Gyll. During June much complaint was made of injury to young growing corn plants by bill bugs. In one field near Whiting, Monona County, I found practically 100% injury by this insect. The field was in sod the year previous and had been turned under that spring. Out of 100 hills in a row, counted consecutively, every hill was more or less injured by the punctures of bill bugs. The species here concerned was *Sphenophorus parvulus*.

Aphis setariæ Thos. Plum trees over the state were badly infested with this species of aphid this year. Probably the worst infestation noticed was at Ames. Here the insect reached its maximum about the middle of June, when the plant lice were so thickly crowded on young plum growth so as to quite hide the wood. One's clothes would become stained by the aphids while walking down a row of badly infested young trees. Early in July lady beetles, mainly *Coccinella 9-notata* Herbst and *Hippodamia convergens* Guer., were very abundant on the infested trees and by July 29th on some of these trees not an aphid could be found. A part of them, no doubt, had migrated to their alternate food plants among the wild grasses, but it was the abundance of the lady beetles that was responsible for the wholesale clearing out of the plant lice.

Leptinotarsa 10-lineata Say. This year the ever-present Colorado potato-beetle was much more common than usual. Early in the season many potato fields were threatened with a stripping, but the use of Paris green in most cases checked the insects.

Epitrix cucumeris Harris. Another insect that was very common on potatoes in Iowa this year was the potato flea-beetle. The injury was first noticed about the middle of June. The beetles were found on the vines from that time until fall. Early potatoes were more injured than the late varieties.

Empoasca mali LeBaron. The apple leaf-hopper also did considerable damage this year to potatoes. The attacks of this insect, together with the injury by the Colorado potato-beetle and the long drought, made potatoes a very poor crop in some localities.

Chaitophorus negundinis Thos. Box elder trees all over the state were attacked by the box elder aphid, which seems to be fairly common in Iowa nearly every year. The plant lice evidently got a start early in the season, when the late frost took all the foliage from the trees, but apparently did not affect the insects. Many trees were not able to put out a full foliage all through the season, due to the attack of this aphid and also to injury by a species of Eriophyes.

Meliana albilinea Hübner. Injury to timothy heads by the wheat-

head army-worm was very common in the northern half of the state this year. This was part of an outbreak that extended into Minnesota and eastern South Dakota. The damage was more serious than it has been for years. In some cases oats were also slightly damaged, but most of the injury was to the timothy. From a series of observations it was found that early fall pasturing of infested meadows greatly decreased the injury in those meadows the following year. Apparently the stock eat the grass down so well that the larvæ of the second generation in the late summer are practically starved out.

Peronea minuta Rob. Several nurseries in the state are again having trouble with the lesser apple leaf-folder. The second and third generations of the leaf-folders were exceptionally numerous.

Grasshoppers became abundant during the summer, especially in meadows and along roadsides. There were two species that were most abundant: *Melanoplus femur-rubrum* DeG., and *Melanoplus bivittatus* Say.

Scientific Notes

An Unusual Invasion of Aedes sollicitans in Louisiana during July, 1910.—On July 12, 1910, notes were made on a very unusual abundance of *Aedes sollicitans* in Pointe Coupee Parish, Louisiana. For several weeks before and after that date all field operations were suspended on account of the mosquitoes. Ordinarily negroes pay no attention to mosquitoes. They very seldom have mosquito bars in their cabins. At this time, however, it was impossible for the managers to force the negroes to work in the fields. Live stock suffered very severely. The cattle from the pastures and woods assembled on high places like the levees. Here they galloped back and forth through the night. The mosquitoes were less abundant in the daytime at least when the sun was shining. During cloudy weather in daytime they appear to be as active as at night. Some animals, more susceptible than others, were attacked to such an extent that the hair was all saturated with blood.

In company with one of my agents and two other men I went into the cotton field on the afternoon of July 12th with a large number of negroes in order to apply poison. The negroes had to be forced to go to the field. During the short time we were able to stay in the field all the members of the party attempted to protect themselves from the mosquitoes by moving the arms violently and stamping the feet. The negroes were as active in this as the white members of the party. In spite of what was done it is very doubtful if, for a single instant, there were less than 100 mosquitoes on each member of the party. Something over a pound of oil of citronella was used but it had little effect. After about half an hour spent in the field, we were compelled to return to the headquarters. Upon nearing the store one of the men frantically jumped from the wagon and ran to seek shelter. He stated that every puncture gave him extreme pain. In my own case no sharp pains were experienced and there were no unusual after-effects.

W. D. Hunter,
Bureau of Entomology, U. S. Department of Agriculture.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1910

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints may be obtained at cost. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—EDS.

The dedication of an admirably equipped building, noticed on other pages of this number, to the training of young men in entomology marks another advance in the rapid progress this science is making in America. Special buildings are provided only when necessary, the need in turn depending largely upon the demand for such technical knowledge and not a little upon the ability of those responsible for the training of the students. The splendid structure recently completed at the Massachusetts Agricultural College is a worthy monument to the ability of a beloved veteran; Prof. C. H. Fernald, who unfortunately has been obliged, on account of ill health, to retire from active teaching. Nearly a quarter of a century of work has made it possible for him to exercise through his students a profound influence upon the development of American economic entomology. It is a pleasure to note that the development of the department he has been so largely instrumental in building up is to be continued along progressive lines. We confidently look for a maintenance of the present high standards and take this opportunity of congratulating the institution upon the possession of such an admirably equipped department.

Schools giving special training in entomology, particularly its economic or practical aspects, are a comparatively recent development, yet excellent is the adjective which must be applied to much of the earlier work by men compelled to fit themselves progressively for the solving of various problems. Considering the numerous handicaps under which our earlier workers labored, it is a question whether any could have done much better. They have laid a solid foundation upon which all subsequent students must build. The enormous development of recent years has been made possible by conditions beyond our control, namely, extended and serious depredations following the normal development of a comparatively new country. The demand for knowledge has stimulated the training of men and, as a result, we have in America unrivaled opportunities for the study of applied entomology, not only in the university and college but

also throughout the country. The investigations of special problems by corps of well trained men means the making of entomological history which will have a profound influence upon our future welfare. The relative importance of different phases of this work can not be accurately estimated at the present time. It will be interesting, a generation or so later, to make a critical comparison between the work of our pioneers and those who have had the advantage of the best training a university or special school can bestow.

Reviews

The Coleoptera or Beetles of Indiana, by W. S. BLATCHLEY, Ind. Dep't of Geol. and Nat. Resources, Bul. 1, p. 1–1386, 590 figures. 1910.

The beetle book has appeared and marks a most important step in further popularizing our knowledge of this extensive order. The author follows the classification of LeConte and Horn and with the coöperation of specialists in many groups has produced a most creditable publication and incidentally laid all entomologists under obligation. The scope of the work, describing as it does, over 2,500 species, compels brevity. Only 24 pages are devoted to introductory matter and that is mostly morphological. The remaining pages consist of a descriptive catalogue exclusive of the Rhynchophora, of all species known to occur in Indiana. Tables are given for the separation of families, tribes, genera and species. The descriptions, though brief, are sufficient for the recognition of most species. Citations of the more valuable papers for both groups and genera and a glossary add much to the value of this work. The large number of illustrations taken from various sources add greatly to the value of the work, though its appearance is somewhat marred by their miscellaneous character.

This work is indispensable to working entomologists, since it is the first attempt known to us to produce a systematic account of the beetles occurring in any representative life zone of America. It will be especially valuable to those in the Central States and of great service to others in approximately the same faunal area. We regret to note that it has been possible to issue only 1,000 copies of this bulletin. The author is to be congratulated upon having completed such an extensive work and it is to be hoped that he will soon be able to publish a similar account of the Rhynchophora.

Insects and Diseases, by RENNIE W. DOANE, Henry Holt & Co., p. 1–227, figures 112. 1910.

This timely, popular work brings together the most important facts, largely from sources inaccessible to the general reader and even to many physicians and entomologists, in regard to the development, habits, structure, life histories and methods of controlling the insects discussed. This little volume illustrates anew the economic importance of the Diptera, since about one half of the text is devoted to discussions of various flies and methods of controlling them. The house or typhoid fly and various mosquitoes, especially the forms conveying malaria and yellow fever, are treated in considerable detail. The chapter on ticks and mites and their part in the dissemination of disease is exceptionally interesting. The chapter devoted to fleas

and plague with its account of conditions obtaining upon the Pacific coast is most pertinent. The excellent series of illustrations, for the most part original, adds much to the value of the volume. The value of this work to the professional entomologist at least, is greatly increased by the somewhat extended and carefully selected bibliography. Only a few errors have been noted. Through an oversight the sexes have been wrongly indicated in figures 76 and 77, while the name of one author cited is given in two different forms, neither correct. The volume as a whole will be found of great service, not only to those desiring a general knowledge of the subject, but also to professional entomologists who may wish to look up the original sources of information.

Current Notes

Conducted by the Associate Editor

Mr. H. F. Wilson of the Bureau of Entomology has resigned to accept a position under Prof. A. B. Cordley at the Agricultural Experiment Station, Corvallis, Oregon.

Mr. John D. Tothill, formerly of the Ontario Agricultural College, Guelph, has been appointed assistant in the Bureau of Entomology of the U. S. Department of Agriculture and has been working since July 1, 1910, on Tachinid parasites of the gypsy moth at the parasite laboratory at Melrose Highlands, Mass.

Dr. Alexander Petrunkevitch of the American Museum of Natural History has been appointed instructor in zoölogy in the Sheffield Scientific School of Yale University.

J. C. Bridwell, instructor in zoölogy and entomology at the Oregon Agricultural College and assistant entomologist of the Station, has resigned to accept a similar position at the University of California.

According to the *Experiment Station Record*, Mr. Charles R. Jones, formerly of the Bureau of Entomology, has accepted an appointment as entomologist to the Philippine Board of Agriculture at Manila, P. I.

According to *Entomological News*, Mr. C. B. Hardenberg, formerly connected with cranberry insect investigations for the State of Wisconsin and for the U. S. Department of Agriculture, has been appointed entomologist to the Transvaal at Pretoria.

Prof. John B. Smith of Rutgers College, and state entomologist of New Jersey, sailed for Europe, August 20, and returned about the middle of October.

According to *Science*, Folsom's "Entomology" has been translated into Japanese by Messrs. Miyake and Uchido of Tokyo.

In the course of lectures on public health problems and the prevention of disease to be given at Teachers' College, Columbia University, one lecture on "Flies and Other Insects as Carriers of Disease" is scheduled for December 5, the lecturer to be announced later.

Harry Evans, assistant entomologist at the Kansas Station, has resigned to accept a position at the Ohio Station.

J. S. Houser, assistant entomologist of the Ohio Station, has been granted a year's leave of absence for post-graduate study at Cornell University.

Mr. H. O. Marsh, agent and expert of the Bureau of Entomology, and engaged in truck crop investigations, resigned his position June 30, 1910.

Mr. W. R. Walton, scientific artist of the Laboratory of Economic Zoölogy at Harrisburg, Pa., has resigned to accept a similar position in the Bureau of Entomology at Washington, D. C.

Prof. H. A. Surface, economic zoölogist of Pennsylvania, conducted a series of public meetings in the model orchards throughout the state during the fall. The results of the spraying experiments and demonstrations were studied and explained.

According to the *Experiment Station Record*, Mr. D. L. Van Dine of the Bureau of Entomology, and formerly of Honolulu, T. H., has been appointed entomologist of the Porto Rico Sugar Producers' Station, with headquarters at San Juan.

Miss C. F. Kephart, B. S. A., a graduate of Cornell University in the class of 1910, and for two years before graduation a student assistant in entomology, has been appointed assistant in the entomological department of the New Hampshire College of Agriculture and the Mechanic Arts.

Mr. W. S. Abbott, who graduated last June from the New Hampshire College, has accepted the position of assistant entomologist at the New Jersey Agricultural Experiment Station, New Brunswick, N. J.

Mr. F. A. Johnson, of the Bureau of Entomology, has been assigned to work at the Virginia Truck Station in place of E. G. Smyth, who has been transferred to other work of the Bureau.

The Board of Directors of the Agricultural and Mechanical College of Texas, College Station, Texas, have recently reëstablished the Department of Entomology in that institution. In 1909 the teaching of entomology was placed in the hands of the Biological Department and was under the supervision of the professor of botany. Under the new arrangement the department of entomology is separate and distinct, with Mr. Wilmon Newell as professor of entomology and Mr. Ernest E. Scholl as assistant professor.

Mr. Arthur I. Bourne, a graduate of Dartmouth College, who took a year of graduate study at the Massachusetts Agricultural College and for the past year has been assistant in the Bureau of Entomology at Washington, has returned to the college at Amherst as assistant in entomology. Mr. Bourne will also continue his studies in the graduate school.

The new building for entomology and zoölogy at the Massachusetts Agricultural College at Amherst, Mass., was dedicated November 11, the principal addresses being given by Dr. L. O. Howard, chief of the Bureau of Entomology at Washington, and Dr. W. E. Hinds of the Alabama Polytechnic Institute, Auburn, Ala. A brief account of the exercises and a description of the building appear on other pages of this number of the Journal. Among other entomologists present besides those residing at Amherst were noticed Dr. E. P. Felt, Albany, N. Y., Mr. H. E. Hodgkiss, Geneva, N. Y., Dr. W. E. Britton and Mr. D. J. Caffrey, New Haven, Conn., Mr. C. W. Johnson and Mr. D. M. Rogers, Boston, Mass., Mr. A. F. Burgess, Melrose Highlands, Mass., Mr. A. H. Kirkland, Huntington, Mass., Mr. H. J. Franklin, Wareham, Mass., and Mr. H. L. Frost, Arlington, Mass.

JOURNAL ECONOMIC ENTOMOLOGY PUBLISHING COMPANY

The annual meeting of the stockholders of this company will be held on December 28 or 29, in connection with the meeting of the Association of Economic Entomologists at Minneapolis, Minnesota. The precise time and place will be announced at the sessions of that Association. Members of the advisory board are hereby notified that it devolves upon them to nominate the elective officers.

E. P. Felt, *President.*
E. Dwight Sanderson, *Secretary.*

Mailed, December 15, 1910.

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TWENTY-THIRD ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Minneapolis, Minnesota, December 28–29, 1910

The twenty-third annual meeting of the American Association of Economic Entomologists will be held at Minneapolis, Minn., on Wednesday and Thursday, December 28 and 29, 1910. The sessions will open at 10 a. m., Wednesday, in Room 24, *School of Mines Building* of the University of Minnesota. At 1 p. m. a joint session will be held with the Entomological Society of America and on the following day sessions will be held in the same room at 10 a. m., and 1 p. m.

If the weather is favorable and the members desire it one of these sessions can be transferred to the Minnesota Agricultural College. This arrangement will give the members an opportunity to inspect the buildings and equipment of the college and to examine the laboratory and equipment of the state entomologist of Minnesota. This matter will be decided at the first session on Wednesday morning.

Other Meetings

The American Association for the Advancement of Science and its affiliated societies will hold meetings throughout the week at the University of Minnesota.

The Entomological Society of America will meet on Tuesday, December 27, and in joint session with this association on Wednesday, December 28, at 1 p. m. The public lecture held by the society will be delivered by Prof. F. L. Washburn, state entomologist of Minnesota, on Wednesday evening. At the close of this meeting an informal smoker will be held in the Dyckman hotel.

The Association of Horticultural Inspectors will meet at 8 p. m., Thursday, and the sessions will be continued on Friday.

Hotel Headquarters

The hotel headquarters of this association and the Association of Horticultural Inspectors will be at the Dyckman, on Sixth Street between Nicollet and Hennepin Avenues. Rates, $1.50 to $4.00 a day on the European plan. Our headquarters are located in the block adjoining the Radisson, the hotel headquarters of the Amer-

ican Association for the Advancement of Science. Members are urged to secure hotel reservations in advance, as the hotel management request that reservations should be made at least ten days before the meeting.

Railroad Rates

All railroad lines have declined to grant reduced rates for the meeting.

Announcement Concerning Program

A full program of the meeting will be published in the general program issued by the American Association for the Advancement of Science. Each member attending the meeting on *payment of dues* will be furnished with the official button of the association and a special program of the meeting.

In accordance with the action of the executive committee symposia have been arranged on "Present Methods of Teaching Entomology" and on "Spraying Machinery—Its Present Desirable and Undesirable Features." These subjects will be presented by some of the best-known entomologists of this country and will be a special feature of the meeting. In connection with the symposium on spraying machinery, members are requested to bring to the meeting, for exhibit or demonstration, any spraying devices which have given superior results and to come prepared to join in a full discussion of both of these important subjects.

PROGRAM

Report of the secretary.

Report of the committee on nomenclature, Mr. Herbert Osborn, chairman, Columbus, Ohio.

Report of the committee on testing proprietary insecticides, by E. D. Sanderson, chairman, Morgantown, W. Va.

Report of the committee on affiliation, by Mr. Lawrence Bruner, chairman, Lincoln, Neb.

Report of the executive committee, by President E. D. Sanderson, Morgantown, W. Va.

Appointment of committees.

Miscellaneous business.

New business.

Annual address of the president, by E. D. Sanderson, Morgantown, W. Va., "The Work of the American Association of Economic Entomologists."

Reading of Papers

"Economic Entomological Investigations Now Under Way," by T. J. Headlee, Manhattan, Kansas.

"Farm Methods for Controlling Southern Field Crop Insects," by A. F. Conradi, Clemson College, S. C. (20 minutes.)

A discussion of fall and winter cover crops, clean cultivation on low lands, effects of terracing and methods of spring forcing of field crops.

"Economic Importance of *Stictocephala* sp.," by Herbert Osborn, Columbus, Ohio. (7 minutes.)

Records of occurrence of *Stictocephala* on cultivated crops and some notes on mode and extent of injury.

"Studies on the Cabbage Maggot," by W. J. Schoene, Geneva, N. Y. (15 minutes.)

Habits and life history in New York State.

"Habits of the Cabbage Aphis with Suggestions for its Control," by Glenn W. Herrick, Ithaca, N. Y. (10 minutes.)

"Fatal High Temperature for the Control of Mill Insects," by George A. Dean, Manhattan, Kan. (10 minutes.)

The results of several experiments in heating a flour mill to temperatures that proved fatal to the insects infesting it.

Adjournment.

Program

Tuesday, December 28, 1 *p. m.*

Joint session with the Entomological Society of America.

Reading of Papers

"Some Notes on the Pear Slug, *Eriocampoides limacina* Retz," by R. L. Webster, Ames, Iowa. (10 minutes.)

"Summary of the Food Habits of American Gall Midges," by E. P. Felt, Albany, N. Y. (10 minutes.)

"Locomotion of Certain Young Scale Insects," by H. J. Quayle, Whittier, Cal. (8 minutes.)

An account of experiments on the rate and distance of travel of the active young of the Black, Purple and Red scales over smooth surfaces, sand and orchard soil.

"Locomotion of the Larva of *Calosoma sycophanta*," by A. F. Burgess, Melrose Highlands, Mass. (7 minutes.)

Record of the distance travelled by a larva of this species from the time of hatching until its death, no food having been furnished, and the method of securing the data.

"The Effect of Certain Gases and Insecticides upon the Activity and Respiration of Insects," by George D. Shafer, East Lansing, Mich. (35 minutes.) (Charts of apparatus and data tables.)

A presentation of the results obtained in a study of the effect of some common gases and insecticides upon the activity and respiration of insects as compared with their normal activity and respiration. The study has been made to obtain evidence that will help in deciding the question, "How do insecticides kill?"

"Instructional Methods in Economic Parasitology with Reference to California," by W. B. Hermes, Berkeley, Cal. (10 minutes.)

Needs of the student and the state in a field of vast importance to public health and animal industry.

Symposium

On "The Present Methods of Teaching Entomology."
Papers by J. H. Comstock, Ithaca, N. Y.
H. T. Fernald, Amherst, Mass.
Herbert Osborn, Columbus, Ohio.
Lawrence Bruner, Lincoln, Neb.

The discussion will be opened by the following members, and a general discussion will follow:

John B. Smith, New Brunswick, N. J.
S. A. Forbes, Urbana, Ill.
V. L. Kellogg, Stanford University, Cal.

Adjournment.

Program

Thursday, December 29, 10 *a. m.*

Discussion of the presidential address.

Reading of Papers

"Methods of Securing the Fertilization of Clover by Means of Bumble Bees in Experiments with *Bruchophagus funebris*," by F. L. Washburn, St. Anthony Park, Minn. (10 minutes.)

"Apparatus for the Study of Subterranean Forms," by S. J. Hunter, Lawrence, Kan. (10 minutes.) Lantern slides.

"A New Sawfly Enemy of the Bull Pine in Nebraska," by Myron H. Swenk, Lincoln, Neb. (15 minutes.) Lantern slides.

A brief account of the ravages and natural enemies and, in part, the life-history of a new Lophyrine enemy of *Pinus ponderosa scopulorum*.

"Notes on the Larch Sawfly in Minnesota," by A. G. Ruggles, St. Anthony Park, Minn. (10 minutes.)

An account of the range of the species and the damage done in Minnesota, with notes on the enemies, both insect and fungus.

"Azolla and Mosquitoes," by John B. Smith, New Brunswick, N. J. (10 minutes.)

Account of investigations made in Germany and Holland on the ecology of Azolla species, and the effect on mosquito breeding.

"Anti-Mosquito-Malaria Campaigns in California—Methods and Results," by W. B. Hermes, Berkeley, Cal. (15 minutes.)

A brief review of the anti-mosquito campaigns carried on under the direction of the writer during the year 1910.

"Oviposition among Tree Crickets," by P. J. Parrott, Geneva, N. Y. (10 minutes.)

Studies of three common species as to egg-laying habits.

"Some Notes on Injurious Leaf Hoppers," by Herbert Osborn, Columbus, Ohio. (10 minutes.)

A discussion of some of the species destructive to cultivated crops.

"Notes on the Wheat-Head Army-Worm, *Meliana albilinea* Hbn., as a Timothy Pest," by R. L. Webster, Ames, Iowa.

Notes on the life-history, habits, food plants, natural enemies and control of the insect.

Adjournment.

Program

Thursday, December 29, 1 p. m.

Symposium

On "Spraying Machinery—Its Present Desirable and Undesirable Features."

Papers by E. D. Ball, Logan, Utah.
A. L. Quaintance, Washington, D. C.
L. H. Worthley, Boston, Mass.
E. L. Worsham, Atlanta, Ga.

The discussion will be led by the following members:
T. B. Symons, College Park, Md.
T. J. Headlee, Manhattan, Kansas.
E. P. Felt, Albany, N. Y.
E. P. Taylor, Grand Junction, Colo.
W. E. Britton, New Haven, Conn.

A general discussion will follow and an opportunity will be offered for the exhibition and explanation of new or improved spraying devices that may be submitted by the members of the Association.

Reading of Papers

"Some Ways of Getting Entomological Information Before the Public," by H. A. Gossard, Wooster, Ohio. (To be read by title.)

"Some Properties that Make Lime and Sulfur Wash Effective in Killing Scale Insects," by George D. Shafer, East Lansing, Mich. (15 minutes.)

The results of experiments that seem to point out the properties of the lime and sulfur wash that make it effective in killing scale insects.

"Life History of the Rice Weevil (*Calandra oryza* L.) in Alabama," by W. E. Hinds, Auburn, Ala.

"Spraying with Linseed Oil Wash for the Oyster Shell Scale," by R. L. Webster, Ames, Iowa. (2 minutes.)

A brief account of a successful treatment of the oyster shell scale with a linseed oil emulsion.

"Results of Test Sprayings for Gloomy and Euonymus Scales," by Z. P. Metcalf, Raleigh, N. C. (10 minutes.)

A brief summary of the results of two years' tests against these insects.

"The Terrapin Scale in Maryland," by T. B. Symons and E. N. Cory, College Park, Md. (10 minutes.)

Discussion of this scale in Maryland, injury it is doing and results of experiments for its control.

"The Woolly Aphis, *Schizoneura lanigera*," by S. J. Hunter, Manhattan, Kansas. (10 minutes.)

Additions to its life history and behavior; experiments in control.

"New Data on the Apple Maggot," by W. C. O'Kane, Durham, N. H. (5 minutes.)

Brief summary of some of the results secured in the past summer's work at the New Hampshire Station.

"Some Results from Spraying for the Codling Moth," by R. W. Braucher, Douglas, Mich. (20 minutes.)

An analysis of some of the results obtained in spraying for the codling moth and some conclusions and problems to be drawn from them.

"Notes on the Egg Laying Habit of *Sanninodea exitiosa* Say," by E. N. Cory, College Park, Md. (7 minutes.)

"A Co-operative Experimental Field System," by A. F. Conradi, Clemson College, S. C. (10 minutes.)

A discussion showing the necessity of such a system under South Carolina conditions and the method by which it is carried out.

"Notes on Some Insects Injurious in Nebraska During 1910," by Myron H. Swenk, Lincoln, Neb. (10 minutes.)

Remarks on several cases of insect damage of a severe or unusual character.

"Entomological Review of the Year in Ohio," by H. A. Gossard, Wooster, Ohio. (To be read by title.)

Reports of committees.
Miscellaneous business.
Election of officers.
Fixing time and place of the next meeting.
Adjournment.

A. F. Burgess, *Secretary*,
Melrose Highlands, Mass.

E. D. Sanderson, *President*,
Morgantown, W. Va.

NINTH ANNUAL MEETING
ASSOCIATION OF HORTICULTURAL INSPECTORS

Minneapolis, December 29 and 30, 1910

First Session — Thursday 8 p. m.

Parlors, Dyckman Hotel

Program

Organization.
President's annual address, F. L. Washburn, St. Anthony Park, Minn.
Report of committee on affiliation, T. B. Symons, College Park, Md.
Report of committee on permanent organization, G. G. Atwood, Chairman, Albany, N. Y.
Miscellaneous business.

Second Session — Friday 10 a. m.

Room 23, School of Mines Building, State University

Call to order.
Discussion of president's address.
"New York Nursery Inspection," G. G. Atwood, Albany, N. Y.
"European Conditions in 1910 and General Inspection Prospects," L. O. Howard, Washington, D. C.
"A Practical Method of Inspecting Imported Seedlings," etc., T. B. Symons, College Park, Md.

Third Session — Friday 1 p. m.

Call to order.
"The Practicability of Nursery Quarantine Stations in Different States," A. H. Conradi, Clemson College, S. C.
"The Health of Plants as Related to Insects," J. B. S. Norton, College Park, Md.
"Report of Committee on Treatment of Infested Nursery Stock in Different States," Franklin Sherman, Jr., Raleigh, N. C.
"Results of Experiments in Dipping Trees and Fumigating Peach Buds," T. B. Symons and E. N. Cory, College Park, Md.
Report of committee on national legislation.
Election of officers.
Miscellaneous business.
Adjournment.

Questions for Discussion

1. The Kind and Form of Information Concerning Individual Nurseries to be Furnished by an Inspector to Inspectors of other States.
2. What is the Opinion of State Inspectors Regarding the Sale of Strawberry Plants from Districts Known to be Infested with the Strawberry Root Louse?
3. What is the Best way to Treat Nursery Stock Infested with the San José Scale where such Stock is to be planted in Infested Orchards or sections, the owners of which do not regard San José Scale Infestation Serious, they having adopted adequate spraying methods for its control.
4. Assuming that Nurserymen may demand that their trees shall be treated for San José Scale instead of being destroyed what formula for treatment should be employed?
5. Why does Fumigation with Hydrocyanic-acid-gas occasionally fail?
6. Will dipping nursery trees in lime-sulfur solution prove effective? If so, should roots be immersed?
7. What action should be taken by Horticultural Inspectors in reference to Imported Bulbs, Herbaceous and Green House Plants.
8. What progress has been made in barring Wormy and Scale Infested Fruits from the Markets in Different States?
9. What is the present state of Crown Gall on Apple?
   A. Relation of Crown Gall and Hairy Root.
   B. Prevention of this disease in the Nursery.
   C. Inspection and Requirements for Crown Gall.
   D. Contagiousness.